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PAPERS

ON

BEDSIDE URINARY TESTS

BY

GEO. OLIVER, M.D., LOND.,

*Member of the Royal College of Physicians
of London, &c., &c.*

NO. I.

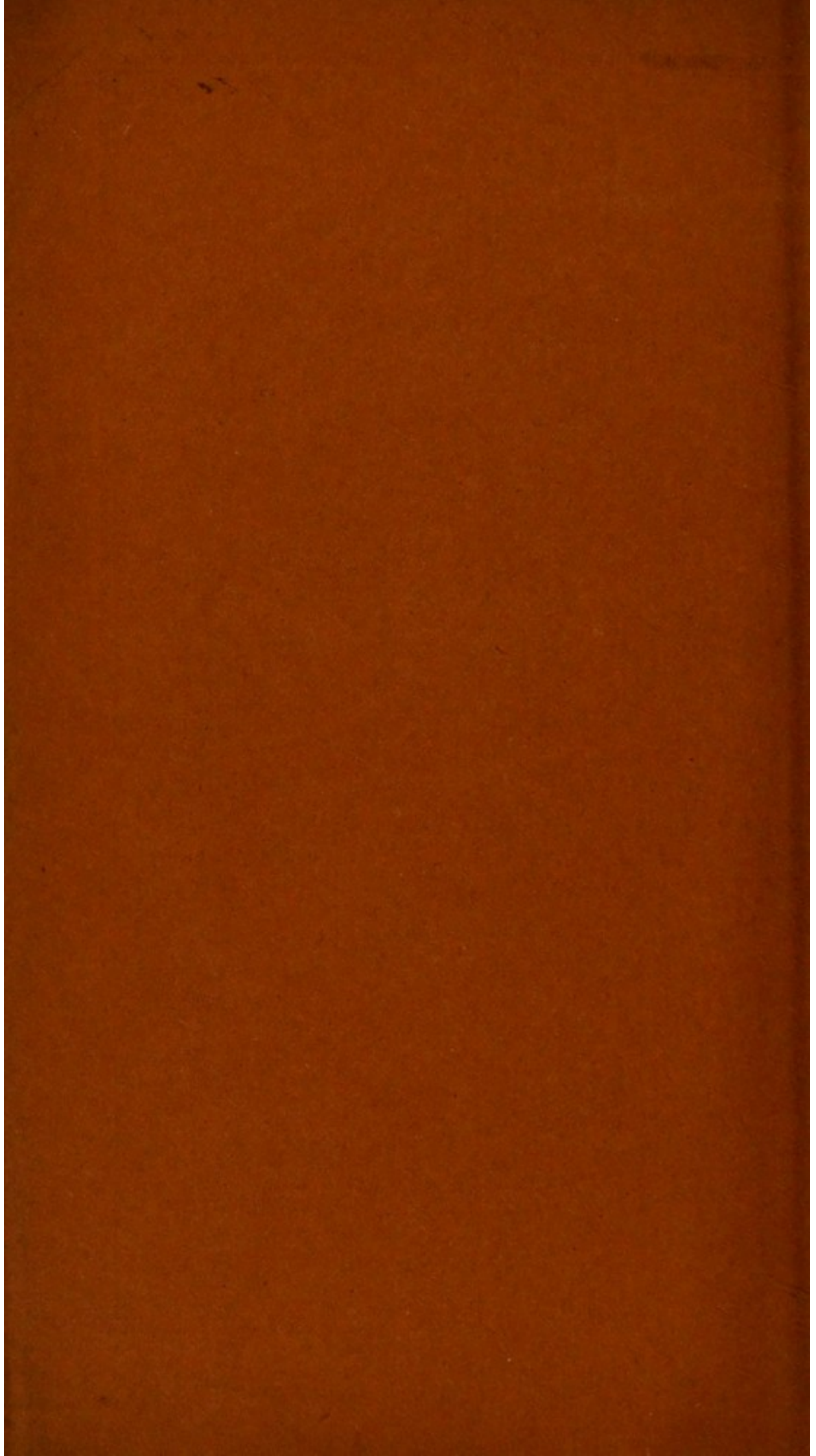
ALBUMEN PRECIPITANTS.

(QUALITATIVE).

Reprinted with additions from the *Lancet*, January 27th
and February 3rd, 1883.

HARROGATE:

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*The Author's Kind
Obedience*

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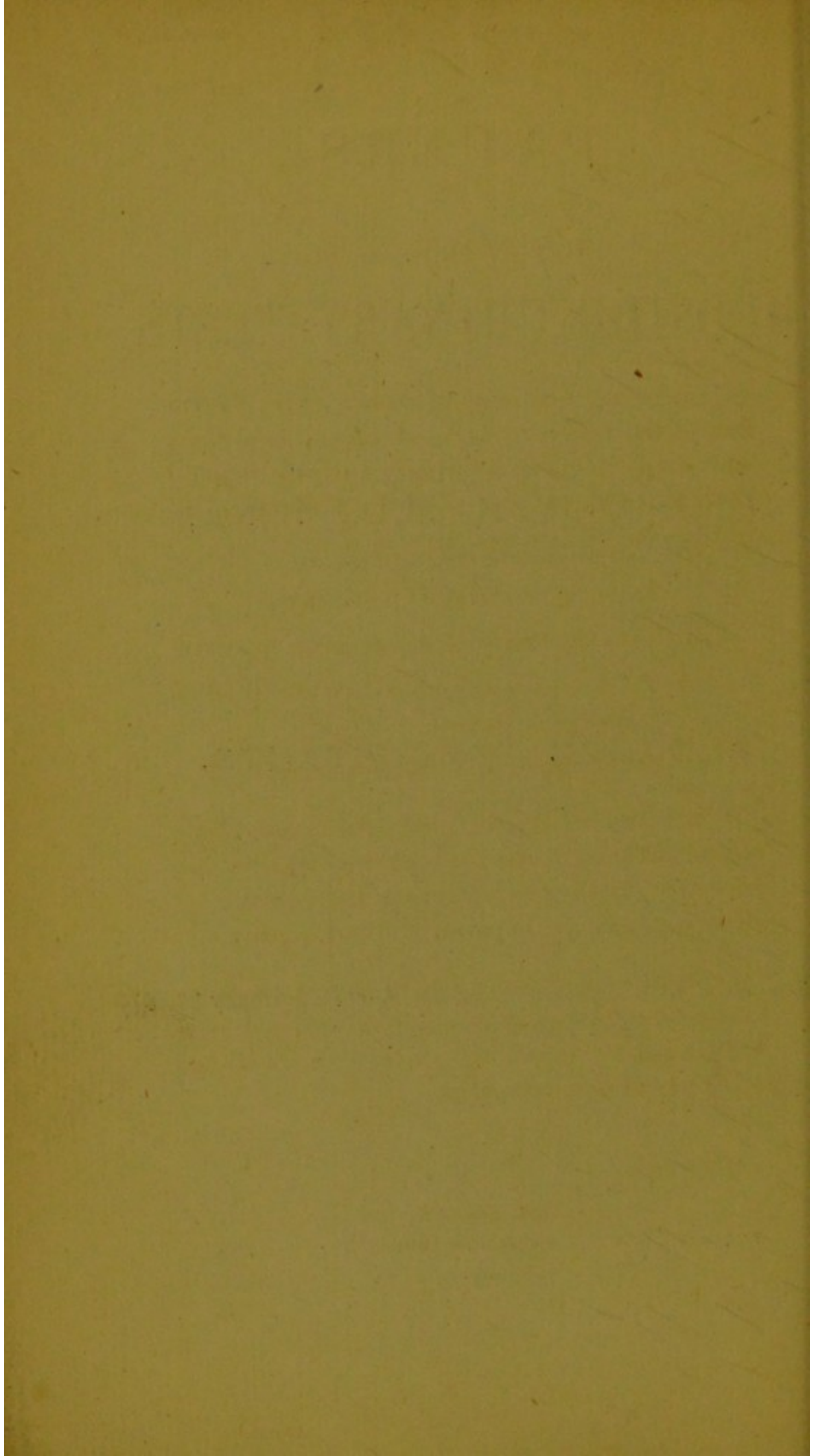
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PREFATORY NOTE.

IN reprinting this article I should state, it is the first of the following series of papers on a ready and simple method of urinary analysis, which I have found useful and handy, not merely at the bedside, but in the consulting room :

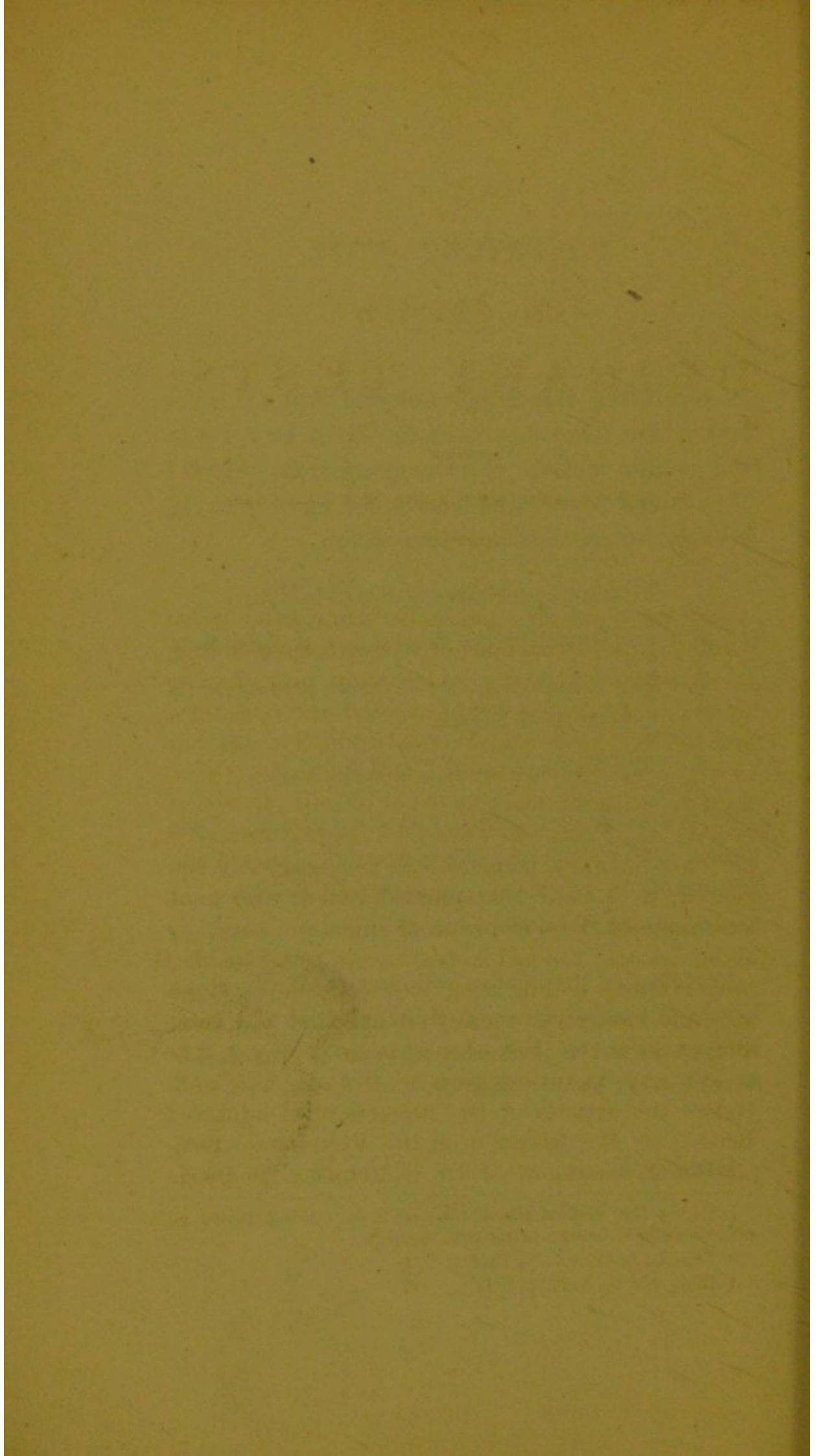
1. Albumen precipitants (Qualitative).
2. The Quantitative Estimation of Albumen.
3. The Estimation (Qualitative and Quantitative) of Sugar.
4. The Estimation of Total Acidity.

The new mode of testing is at once cleanly, time saving, and exact; and the reagents employed are presented in the most compact and portable of all forms—namely, as pieces of filtering paper.

Perhaps, as the reader follows the simple steps herein described, he may think of that old test, Litmus paper, as but the embryo of the fuller development here presented.

Harrogate,

February 5th, 1883.



ON BEDSIDE URINARY TESTS.

BY GEO. OLIVER, M.D., LOND., M.R.C.P., LOND.

ALL busy practitioners must admit the clinical utility and importance of accurate, time-saving, and portable tests, by which they may, during their rounds, decide with precision and certainty, and on the spot, pathological conditions of the urine, or satisfy themselves, and their patients, if need be, without delay as to the soundness of that excretion. From the numerous contributions on portable urinary tests which have recently appeared, it is clear that practical men, who have long realised the serious inconvenience of carrying about caustic fluids for testing at the bedside,¹ are anxiously feeling their way to more manageable and handy yet equally trustworthy reagents; and I take it the profession at large is prepared to accept any useful suggestions towards this end. Hence the articles of Dr. Roberts on Acidulated Brine,² of Mr. Stephen on the Volumetric Estimation of Albumen,³ of Dr. G. Johnson on Picric

¹ Hence the fact of many medical men having given up urine testing entirely during their rounds.

² THE LANCET, vol. ii., 1882, p. 613.

³ Ibid., vol. ii., 1882, p. 614.

Acid, and of Dr. Pavy. The corrosiveness of Nitric acid and the causticity and instability of Fehling's solution, rather than want of faith in the trustworthiness of these tests, have doubtless mainly prompted the suggestion of more portable reagents. In the substitutes we therefore seek for compactness, handiness, and portability, without the sacrifice of the generally admitted reliability of the old forms for clinical purposes. Doubtless others besides myself have been trying to supply this desideratum, and may be prepared to offer useful hints. Having, however, attained to certain results which have satisfied my own clinical needs, I feel I should not delay further in communicating them to those of my professional brethren whom they may interest; and I do so with the hope that they may prove useful, especially in the saving of time to busy men, and may facilitate urinary investigation at the bedside.

My experiments have embraced the qualitative and quantitative testing of albumen, sugar, and total acidity. I should make the preliminary statement that I have succeeded in all my reagents in abolishing the fluid state, and likewise the solid form, either of powder, crystal, or pellet. It occurred to me some time ago that evaporation of the test fluids I was then using on chemically inert filtering-paper, linen, or other similar fabric, would secure the deposition of the reagents in a finely divided and concentrated state, a condition it was hoped favourable to such a rapid re-solution of them in the urine as to produce a quick and sensitive action on the constituents sought for. I soon discovered that my pieces of chemically charged paper were, when dropped into a small

quantity of the urine in a test tube, very delicate and cleanly tests; and being in the most portable and compact of all forms for clinical work, and, moreover, affording better results than I had previously obtained from the old corrosive test solutions, it was not long before I cleared my spoilt urinary case of the latter; and I can assure my readers I did so with a feeling of satisfaction and comfort. Then, inasmuch as it was an easy matter to graduate the papers with standard solutions of the reagents, I next proceeded to inquire how far this simple process could be carried in determining the quantities of albumen, sugar, and total acidity; in other words, I thus attempted to apply at the bedside the volumetric method of analysis in the form of pieces of filtering paper charged with definite quantities of the reagents. Up to the present I am satisfied in having attained rapid and, for all practical purposes, sufficiently accurate results. I intend shortly, as a matter of curiosity, to scrutinise the figures indicated by my paper method for the estimation of albumen by the side of the burette with its standard solution; and I hope on some future occasion to be able to state definitely how near I can approach quickly at the bedside the results which can only proceed from the laboratory with its attendant delay. I must content myself in the present communication with my notes on—

THE QUALITATIVE ESTIMATION OF ALBUMEN.

When Picric acid was first brought forward by Dr. G. Johnson as a remarkably delicate test for albumen, it occurred to me as likely to assist in deciding the sensitiveness of the various albumen

tests from clinical evidence rather than from the laboratory, to take a series of urines containing very small proportions of albumen, to subject them to all the best-known tests, and to carefully tabulate the results. Since then I have met with twenty urines, among others, which supplied the required condition; all being faintly impregnated with albumen presumably derived from the presence of a small quantity of pus, or of blood, or of both, as determined by the microscope.¹ The table of results annotated at the time of every testing is before me. All the urines were acid except one, which was alkaline. The reagents employed were the following:—

1. Strong Nitric acid.
2. Boiling the sufficiently acid urine and afterwards adding dilute nitric acid.
3. Saturated solution of Potassium ferrocyanide, and the urine freely acidulated by citric acid, as suggested by Dr. Pavy.²
4. Saturated solution of Picric acid as advised by Dr. George Johnson.
5. Acidulated Brine after Dr. Wm. Roberts.
6. Standard solution of Potassio - Mercuric Iodide, after Tauret, and recently brought to notice by Mr. Stephen, with this modification—strongly acidifying the urine with citric acid instead of acetic.

The test fluid and the urine were in all the experiments brought into contact, as in Heller's method of using strong Nitric acid, and the line of

¹ Whenever albumen was detected by any of the reagents mentioned in this paper, the urinary deposit was subjected to microscopical examination, and the impregnation was indicated, or at least suggested by the presence of blood, pus, or casts.

² See THE LANCET, vol, ii., 1882, p. 823,

juncture was carefully examined for at least five minutes. Out of the twenty urines strong Nitric acid failed to indicate the presence of albumen in sixteen instances, Boiling in fourteen, Acidulated Brine in fourteen, and Potassium ferrocyanide in twelve; while Picric acid and Potassio-Mercuric Iodide gave a distinct and generally a sharply defined ring of precipitated albumen in every case.

By the side of these reagents I likewise experimentally tried Citric acid dissolved in the Picric solution—two drams to one ounce—and it invariably afforded a more rapidly formed and better defined zone than resulted from Picric acid alone; and, moreover, when the urine and the Acidified Picric solution were afterwards shaken together, the opacity from precipitated albumen was greater than when the simple Picric solution was used. Hence, I conclude that, in detecting small quantities of albumen in urine, the power of Picric acid is quickened and intensified by the presence of Citric acid.

The reaction was indicated by varying degrees of rapidity by the different tests; I must name the Potassio-Mercuric Iodide, Picric-cum-Citric, and Picric acid as the readiest; and of the three I would, if pressed for a preference, decide in favour of the first and second. I found as a rule strong Nitric acid, Acidulated Brine, and Potassium Ferrocyanide much slower whilst bringing to light mere traces of albumen. * I should here remark that I do not attach much clinical importance, so far as I can see at present,¹ to the ability which the most sensitive of these tests possess

¹ Since writing the above, observations have, however, caused me to modify my first-formed impressions as to the clinical value of the keenest albumen precipitants as at present known.

in the detection of albumen in minimal proportions; for, if I did not do so, it might be justly thought by the practical physician that such observations as these indicate an ultra-refinement in testing of no utility in daily work. They were simply made for the definite purpose of affording data suggestive of the most thorough of all the best tests for the discovery of albumen in urine; and as such they undoubtedly point to the Potassio-Mercuric Iodide, Picric-cum-Citric, and Picric acid; and to Potassium Ferrocyanide and Acidulated Brine as next in order.

The same method of testing (Heller's) was followed throughout these observations for the purpose of securing uniformity in gauging the results. But I must say with regard to Potassium Ferrocyanide, that I am not quite satisfied as to whether the capacity of this test as an albumen precipitant was in this way fairly put to the trial; for, on several occasions I noticed the production of a very slight opacity all through the urine instead of a well-defined zone. I am, therefore, with this qualification in my mind, inclined to think somewhat better of it than the above recorded number of failures might lead one to suppose.

The outcome of these observations, as well as of more recent ones, suggests to me the grouping of the tests in the following rising order of power to detect small quantities of albumen:—1. Strong Nitric Acid and Boiling. 2. Potassium ferrocyanide and Acidulated Brine. 3. Picric acid, Potassio-Mercuric Iodide, and the two new tests brought forward in this paper. I have, as a rule, found the members of each group to be nearly equivalent, and confirmatory of each other; and, further, the albumen which strong Nitric acid

and Boiling discovered was always detected with greater facility by all the other reagents, and those tests which comprise the third group frequently revealed traces which the others failed to bring to light; lastly, Potassium ferrocyanide and Acidulated Brine certainly took precedence over strong Nitric acid and Boiling.

As confirmatory of the foregoing observations I may mention that I lately supplied an analytical chemist with some strongly albuminous urine, and he subjected it in the following way to a comparative examination by strong Nitric acid and the tests I am introducing in the paper form. After diluting the urine until the albumen was just detectable by the acid, he proceeded to further dilution, when, the reaction failing to appear, the more delicate paper tests still distinctly indicated the presence of the albumen.

The albumen precipitants which I find to work well as test papers are :

1. Potassio-Mercuric Iodide.
2. Potassium ferrocyanide.
3. The two new tests.
4. Picric acid.

1. *Potassio-Mercuric Iodide* was recently introduced by Mr. Guy Neville Stephen to English readers¹ as an albumen precipitant discovered by Tauret, of Troyes. I select it for production as a test paper because I formed a favourable opinion of it while working it side by side with the other tests, and because it enables one to readily determine the quantities of albumen at the bedside. I moreover found that this double halloid mercuric salt could be evaporated to dryness on filter-

¹ Op. cit,

ing paper without impairing its albumen precipitating power ; and the charge thus communicated still retains its integrity, though introduced over six weeks ago. Each paper contains one-fifth of a cubic centimetre of a standard solution of Mercuric Iodide, the formula for the preparation of which will appear in an article "On the Quantitative Estimation of Albumen at the Bedside." In the mean time I should say it differs considerably from that given in Mr. Stephen's paper. Hitherto, whenever the presence of albumen was indicated by this test paper, corroboration was furnished by Picric acid, and the other tests of kindred power ; and when the amount of albumen was such as to bring it within the range of less sensitive reagents, these also afforded confirmation. This mercuric salt is said to cause a quasi-albuminous precipitate in the urine of patients taking alkaloids ; but I am not yet convinced of the correctness of this assertion, which I must for the present leave, from want of conclusive evidence, neither positively confirmed nor denied. To this test I have repeatedly subjected the urine of one patient taking six grains of Extract of Opium every night and two grains of Codeia twice a day, of another having two daily subcutaneous injections of Morphia and Atropia, and of another taking fifteen grains of Salicine three times a day with this result : a very faint cloud on adding the paper and a delicate ring by the 'contact' method of testing ; but the same reactions followed the use of Picric acid, and the microscope revealed the presence of pus cells. After giving up the Salicine, the urine still gave the same faint indications of albumen in small quantity. But should this source of error exist, it is not likely to induce

more than a semblance to the merest traces of albumen, and it is, moreover, easy to guard against it. Then again, should a patient be taking an alkaloid, this series of test papers provides other equally sensitive albumen precipitants.

2. *Potassium ferrocyanide*, when deposited to saturation on filtering paper, produces in conjunction with citric acid paper a reliable work-a-day test for the detection of albumen in urine. In my hands it has proved almost as sensitive as the other test papers here brought forward. The idea of combining the ferrocyanide with citric acid originated with Dr. Pavy,¹ who proposes to introduce them to the profession as a compound pellet. As thus presented, this albumen test will doubtless be compact, portable, cleanly, and efficient. Perhaps, however, some practitioners may prefer to carry in their visiting lists, or otherwise, leaflets of ferrocyanic and citric paper, rather than a bottle or other vehicle enclosing the pellets. The great convenience of this test paper, as of all the others, must appear when it is known, that at the bedside no further apparatus is required for the detection of albumen than a teaspoon or a wineglass.

3. *Two new albumen precipitants*. — During the past few weeks I have become acquainted with two precipitants of albumen in urine, which, so far as I know, have not received attention from the profession—at any rate in this country; and I am not aware that either of them has been hitherto applied as a urinary test. But until lately I felt some hesitation in introducing them to professional notice, lest by doing so, I should unhappily create greater uncertainty as to the

¹ THE LANCET, vol. ii, 1882, p. 823.

choice of the best and most generally useful albumen precipitant for clinical purposes than at present prevails; for I take it that medical men—at any rate many of the readers of the *THE LANCET*—are just now somewhat perplexed by the rival claims of Picric acid, Ferrocyanide of Potassium, Acidulated Brine, and Potassio-Mercuric Iodide on the one hand, and by their adhesion to the older methods, in which they have trusted so long, on the other. But favourable observations as to the clinical efficiency of these, what may be styled the latest competitors, and a desire to extend my paper method of analysis to other reagents, which may at least be sometimes usefully employed to determine results of a doubtful character, have, however, decided me to ask my brother practitioners to give these new tests a trial by the side of the others.

(a). *Potassio-mercuric iodo-cyanide*.—While working with mercuric cyanide for another purpose, I found that when alone in saturated solution in water it failed to cause a precipitate in albuminous urine, highly acidulated by citric acid; but when mixed with potassium iodide, it threw down the albumen at once as a voluminous white cloud. The iodide and the cyanide combine, and produce a new double mercuric salt ($4KI, HgCy_2$), which crystallises out of solution as beautiful colourless needles. When the solution of this iodo-cyanide is acidified by citric or other acid, a gas (hydrocyanic acid) is liberated, which, when completely expelled by heat, leaves the albumen-precipitating power of the solution unimpaired. It would therefore appear that this free hydrocyanic acid takes no part in throwing down the albumen, and that the precipitation must be ascribed to the

mercuric iodide combination with potassium iodide held in solution. If so, this is but another form of the potassio-mercuric iodide test ; but whether it will prove in some way more useful than the latter, I cannot as yet say. It can, however, be readily reduced to paper ; and when thus employed, I have always found it as rapid and as sensitive as the other albumen test papers, all of which have hitherto afforded corroboration of its integrity and trustworthiness as an albumen precipitant.

(b). *Sodium Tungstate* is another delicate test for albumen in urine. According to the Journal of the Chemical Society, for March, 1874, it is stated that this salt had been employed by F. L. Sonnenschein as a sensitive blood test—producing with ammonia a deep green colour, even when the blood was so dilute as not to be recognisable by the spectroscope—and as an albumen precipitant in the presence of acetic or phosphoric acid. I suppose this important observation has not attracted the notice of clinical observers, for I am not aware of any reference to it in the medical journals in its obvious applications to urinary analysis. On mixing together equal parts of the saturated solutions of the tungstate (one in four) and of citric acid (ten in six), and of water, I obtained an albumen precipitant of great delicacy, rapid in operation, and one moreover, so far as I have ascertained, devoid of all objectionable qualities. When merely dropped into the urine, or used after the manner of Heller, it has always quickly revealed the same minimal proportions of albumen as could only be brought to light by Picric acid and by the other tests of equal keenness. This combination, when evaporated to dry-

ness on filtering paper, gives results very satisfactory, and the test paper thus produced is, in my opinion, one of the readiest and most sensitive of this series of albumen precipitants. The further capacity of this reagent as a detector of blood, at any rate in urine, I am sorry to say I cannot as yet confirm.

Perhaps one or other of these albumen test papers will be found equally convenient in the consulting room as in the daily round; but should any practitioner prefer for the former a single solution, which will not stain the fingers, be free from all other objectionable qualities, and will, moreover, be stable and always ready for use, let me specially mention the acidified solution of Tungstate, which has given me every satisfaction, and which I now prefer to any other liquid test for home use.

Sodium Tungstate is procurable as dry, non-deliquescent crystals, and is, moreover, very cheap; for a shilling will purchase as much as can be needful for the detection of albumen during the whole life-time of the busiest practitioner.

Citric Acid.—All the foregoing reagents are inoperative as albumen precipitants unless the urine is highly acidified; their application should therefore be preceded or accompanied by a sufficient charge of acid. For this purpose citric acid is easily made available when deposited to saturation on filtering paper, and in this form it has afforded me uniformly satisfactory results with all the albumen test papers.

Compound Papers.—Instead of using citric paper separately prior to the reagent paper, it has been combined by a thin layer of rubber with the latter as a single test paper in the case of Potassio-Mer-

curic Iodide. The Picric and the Tungstate are likewise presented as compound papers; but in these instances chemical reasons do not appear to be sufficiently cogent to necessitate the separation of the Citric acid from the reagent: the two are, therefore, deposited together in the same paper.

4. *Picric acid* can be deposited to saturation on filtering paper, which becomes a most compact and cleanly vehicle, and which, moreover, quickly delivers its charge to water. Repeated observation has shown me that when united with Citric acid, as in the test papers, Picric acid is divested of most of the objections that have been urged against it. A few drops of albuminous urine instantly turn the bright Picric solution, extemporaneously prepared from the test paper, into a muddy one, while the addition of more urine does not dissolve the precipitate with anything like the same readiness as when Picric acid alone is used. Then, again, it has been objected that Picric acid is apt to fail in albuminous urine when neutral or alkaline—a condition which is met by the Picric-cum-Citric test. The best way to use the Picric papers is to place one across the bottom of a test tube, and then to drop the suspected urine upon it; on shaking the tube, or even before doing so, the urine will become turbid from precipitated albumen, but will retain its transparency if albumen-free. If the urine, even though heated, be cloudy to start with, it is advisable, before dropping it into the test tube, to add about fifteen minims of water to the Picric paper; then a perfectly transparent and concentrated solution of Picric and Citric acids will be almost instantaneously prepared. For the detection of small quantities or mere traces of albumen, the 'contact' method of

testing should be preferred; it can be easily applied by gliding the urine down the side of the test tube containing the readily prepared solution of the paper, even though the latter is allowed to remain.

How to use the test papers.—About thirty minims of the urine are taken up by a nipple pipette, or medicine dropper, and transferred to a short test tube—preferably one about two inches in length. If turbid from urates, it should be gently heated. It is now strongly acidified by dropping into it a citric paper, which is shaken about for a few seconds, and may then be withdrawn or allowed to remain. It is not now necessary to ascertain if the urine is sufficiently acid; therefore without delay the test paper selected is allowed to fall into it. A simpler plan, and one which I find answers equally well, is to drop both the citric and the reagent papers into the urine, so that they may fall together to the bottom, and to one side of the tube. The latter is now inclined, so that the urine may repeatedly and slowly flow over the paper; when, if albumen be present in small quantity—*e.g.* below a quarter of a per cent.—a whitish cloud will very quickly gather above and below it, will collect at the bottom of the test tube, and will be the more readily detected by intercepting the light by the hand, &c.; while, in striking contrast, the upper part of the urine will remain clear. If, however, the albumen exists in larger proportion, it will not usually produce a haze, but will coagulate about the paper, and will fall from it in clots. The observer may now merely hold the tube in a vertical position, and watch the rapid precipitation of the albumen into the lower portion of the urine,

where it will gather as a cloud, the density of which varies according to the albuminous impregnation; while he will note the unaltered condition of the urine above. Or he may at once shake the tube when the urine will become less or more opaque, according to the amount of albumen present. If, on the other hand, the urine preserves its brightness, or if any turbidity it possessed prior to the introduction of the test paper is not increased, it may be inferred it is free from albumen. But inasmuch as it is just possible—though I have never found it so—it may not have been sufficiently acidified to enable the reagent to throw down the albumen, it is advisable to dispose of this suspicion by adding another citric paper; when, if no precipitation occurs, albumen is absent. The whole proceeding, of course, takes up very much less time than that occupied in reading this description of it. The reaction is practically instantaneous when the urine has been freely acidified prior to the introduction of the test paper. It is, however, not quite so quickly obtained, though the delay only amounts to a few seconds, when, without previous acidification, the single compound test papers are used. The convenience and simplicity of the testing for albumen by these combined papers are very great, for the practitioner only requires to carry them in his visiting list or pocket book and to drop one into a little urine in a teaspoon or wineglass, when, after stirring it about for a second or two, the opacity of precipitated albumen will appear.

Those who prefer to develop a zone of precipitation along the plane of contact of a test solution and the urine, can do so by aid of these papers.

A test tube and a wineglass are required. Into the latter the reagent paper rolled up is placed with about fifteen minims of water, and, without shaking, is set aside, while a similar quantity of urine is put into the test tube with citric paper. After withdrawing the latter, the reagent, now in solution, is taken up by the pipette and is allowed to trickle down the side of the tube, in which it will either glide over the urine or collect below it. After developing the ring, the two fluids may be shaken together, when the albumen will be more largely precipitated as a milky cloud.

Lately I have derived much satisfaction in using the papers in the following simple manner : place at the bottom of a test tube, one of the compound papers, or a citric paper with one of the reagent papers previously bent into a horse-shoe shape ; then let the urine from the pipette trickle down the side of the tube until it covers the upturned ends of the paper, when the turbidity of precipitated albumen, if present, will at once appear, even though the tube be not shaken. On diluting a urine of known per centage of albumen, I have repeatedly, by aid of all the albumen test papers applied in this easy fashion, detected with readiness even as small a proportion as the one-hundredth part of a per cent.

If it be suspected there may be more albumen in solution in any sample of urine than is within the range of one precipitant paper, it is only necessary to add another, taking care to use a citric paper also, if one of the compound test papers is not selected.

The keeping power of the test papers.—None of the papers have been bottled or kept from the air and light during several weeks ; on the other hand,

they have been purposely exposed without covering. Still I cannot discover the least deterioration of their power to precipitate albumen, or any change of colour, or of other physical quality. From the first I rather suspected the mercuric papers might not stand the exposure of daily work for any length of time; but I am now of opinion I over-estimated, if I did not misjudge, this possible source of failure. I am surprised they do not partake more than they appear to do of the deliquescence of the potassium iodide, which is merged in the new definite salts with which they are charged; for it was only after free exposure in a dampish room without a fire—a trial to which no delicate test should reasonably be submitted—that they became slightly limp, but even then without showing any diminution of their albumen-precipitating property. So far I can assert I have seen nothing to cause me to doubt the stability of even these reagents employed as test-papers, and they are the only members of this series of albumen precipitants which *a priori* might be thought at all susceptible to the deleterious effects of atmospheric influences. Though referring to a test touching another subject, I may say that my cupric papers, designed for the qualitative and quantitative estimation of sugar, and made over two months ago, are to-day as good and as sensitive as they were when freshly prepared.

In a leader of the *Medical Times and Gazette* for 1874¹ will be found the following passage, which tersely expresses the opinion of the writer as to the trustworthiness and adaptability to the requirements of medical work of the tests for the

¹ Vol. ii., p. 366.

detection of albumen as then known : " The reader who has followed us so far will, we think, agree with us that none of the common tests are quite satisfactory, and that we still lack one which shall be cleanly, portable, cheap, and certain." I leave it for my readers to decide whether this remark still holds good.

In concluding these notes on the qualitative tests for albumen, I must state my consciousness of the imperfection of isolated observation, however faithfully recorded, and I would fain seek the scrutiny of many eyes, to correct if needful, or to more truthfully limit, any of the matters here advanced. With this object in view I have asked Mr. Hawksley, 357, Oxford-street, W., to place a limited supply of these test papers at the disposal of the profession, and to furnish gratuitously the series to anyone who desires to put them to a careful trial, and who will kindly communicate the results of their observations to me or to THE LANCET. In the meantime I hope that favourable evidence will not be long in forthcoming to prove, as I have found, how satisfactorily they meet the requirements of daily work at the bedside, and to indicate which of them should be regarded as the best workable tests.