42 cases, 2 died undelivered, 7 occurred in the puerperium; the effect of delivery on the remaining 33 is here shown:

No effect, or fits ceased three hours before delivery ...	21
Fits ceased at delivery, though frequent up till delivery ...	4
Fits mitigated after delivery, though severe just before delivery ...	3
Fits more severe and frequent after than before delivery ...	5

These figures strongly support Herman's contention that delivery has no definite influence in cutting short the convulsions. But, besides the effect on the convulsions, we must consider the effect of *accouchement forcé* on the patient. One cannot adopt a line of treatment to benefit the fits if it is shown to be harmful to the patient. Herman found that the chances were about 2 per cent. better if delivery were hurried than if an expectant attitude were maintained. In my 50 cases I find the death-rates with *accouchement forcé* and with expectant obstetrical treatment exactly equal; but of the 7 patients in the above table, where *accouchement forcé* had a good effect on the convulsions, 6 died within a week from sepsis, cardiac failure, or oedema of the lungs. This very strongly suggests that the good effect on the fits may have been secured at the expense of the patient, and it is sufficient to show that *accouchement forcé*, even when the patient is "deeply" under chloroform, is a very severe shock to her, and an extra risk.

In these 50 cases, of the 42 which occurred before the birth of the child, only 4 were during the expulsive stage. It is important to note the difference in the two clinical types: (1) those occurring in pregnancy and early labour, and (2) those occurring during the second stage. In the first class the patient has probably been in the pre-eclamptic condition for some time, and the slight additional irritation of the first pains of labour is sufficient to determine reflexly convulsions which were already impending. In the second type the toxæmia may not have been well marked, and the strong stimulus of the expulsive pains in the second stage is required to bring about the loss of balance of the cortical centres.

If such a case be immediately chloroformed and delivered by forceps she will probably have few succeeding convulsions or none, but to apply the same treatment to a patient whose labour has not begun, or is in an early stage, is adding another risk, and is not only useless but harmful treatment.

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THE SURFACE TENSION OF URINE IN HEALTH AND DISEASE:

WITH SPECIAL REFERENCE TO ICTERUS.

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IN recent years the chemical examination of physiological fluids has been considerably supplemented by an application of the newer physico-chemical methods. Amongst these may be mentioned determinations of freezing point, electrical conductivity, refractive index, viscosity, etc. Thus the freezing point of urine has been employed in the clinical diagnosis of renal disease, whilst the freezing point of milk affords valuable information to the analyst and the medical officer of health. Extensive researches have also been carried out both in this country and abroad on the electrical conductivity of urine. In the regions of physiology, as distinct from those of applied pathology and clinical diagnosis, reference may be made to the brilliant researches of Paul and his pupils on the equilibrium of uric acid and the urates, to the electro-chemical investigations on the question of the so-called alkalinity of the blood, and to the innumerable kinetic investigations on the mode of action of the salivary, gastric, and pancreatic ferments. With regard to the vital question

of immunity from disease, there is every hope at present that the modern methods and results of physical chemistry, more particularly those pertaining to the nature and mutual action of colloids, will be of great service. It is, however, with the direct employment of physico-chemical methods in the clinical diagnosis of disease that we are more particularly concerned in the present paper.

I. OBJECTS OF INVESTIGATION.

Without attempting any analysis of the already very extensive literature in this department of science, the subject in hand may be illustrated by a reference to the work of Ph. A. Guye and St. Bogdan.¹ The methods referred to above are here considered in relation to urine. The nature of the results obtained will be immediately evident from the following table:

	Normal Urine.	Pathological Urine (Tuberculous).
Electrical conductivity (18° C.) ...	0.01937	0.00929
Lowering of freezing point ...	1.39	0.39
Coefficient of viscosity (18° C.) ...	0.0113	0.0109
Index of refraction (n_{18°) ...	1.3397	1.3355

The pathological urine exhibits a very much smaller conductivity and freezing-point depression, thus pointing to a great diminution, not only in total dissolved matter, but also in those constituents (salts) which conduct the electric current.

Of course, variations such as these can only acquire value for the physician when they are considered in the light of an extensive experience of similar measurements made on urine under varying conditions of health and disease.

Whilst considering this subject, it occurred to us that it would be of interest to carry out an investigation on the surface tension of urine, as it is already known that, under certain pathological conditions (icterus), the surface tension of urine is liable to be greatly lowered. In this connexion the simple and easily carried out sulphur test of Matthew Hay will probably be familiar to every physician. Special experiments have shown that Hay's test is of very considerable delicacy—for example, we found it was easy to detect an addition of 0.1 per cent. by volume of ox bile to normal urine, the limit being apparently reached at about 0.04 per cent. This method, however, gives only qualitative results, and is therefore not adapted to the purposes of scientific investigation.

Many methods are available for the measurement of surface tension, but the majority of these are unsuitable for the purposes of clinical diagnosis. In the choice of a method we have been guided by two main considerations: (1) The method must be simple and easily carried out, and must not involve the employment of delicate or elaborate instruments; (2) the method must be such that the results are not affected by accidental contamination of the surface of the urine to be examined.

As is well known, the surface tension of water is greatly lowered by a very small amount of greasy or fatty matter. Since it would in general be difficult to guard against such contamination under ordinary circumstances, it will be seen that the second condition referred to above is sufficient to exclude the majority of the methods commonly in use, since in these methods there is no constant formation of a new surface from the bulk of the liquid, although the contaminated surface can be purified by adopting special precautions. This condition is, however, satisfied by the method in which the liquid to be examined is allowed to drop slowly from a pipette and the number of drops contained in a given volume of fluid counted. As this method, moreover, requires only very simple and easily-constructed apparatus, it is clearly the one which is best adapted to the purposes of clinical work.

The general principle may be easily explained. The hanging drop is supported against the action of gravity by the tension acting in the surface of the liquid. It has been shown that for an orifice of given diameter the surface tension is proportional to the weight of the drop.² If v be the constant volume of liquid delivered from the pipette (as determined by two marks on the stem), d the density of the liquid, and n the

number of drops, the weight of a drop will be equal to $\frac{w}{n}$. Hence, for the same dropping pipette, the surface tension will be proportional to $\frac{d}{n}$ —a relation which may be stated in the form $T = k \frac{d}{n}$ —where T is the surface tension, and k a constant, independent of the nature of the liquid employed. In order to determine surface tensions by this method, we require to determine k first by employing a liquid of known density and surface tension. Denoting the value of these quantities for the standard liquid by d_0 and T_0 , and supposing it gives n_0 drops, we have

$$T_0 = k \frac{d_0}{n_0},$$

and therefore

$$k = \frac{n_0 T_0}{d_0}.$$

Hence we get

$$T = \frac{n_0 T_0}{d_0} \cdot \frac{d}{n}.$$

This formula enables us to calculate the value of T for any liquid as soon as we have determined d and n . If we wish to express the surface tension of the liquid under examination as a percentage of that of the standard liquid at the same temperature, we have at once—

$$\text{Required percentage} = \frac{T}{T_0} \times 100 = \frac{n_0}{d_0} \cdot \frac{d}{n} \times 100.$$

For clinical purposes this latter method of expressing the results is very convenient.

Recently this method of determining surface tensions has been subjected to a very searching inquiry by Guye and Perrot.³ According to these researches it would appear that in order to obtain very accurate results it is necessary to introduce two corrections, one of which is a function of the total number of drops, the other of the time of formation of a drop. Tables of the corrections to be employed are given in the second of the two papers referred to above. Unfortunately, these tables are not sufficiently extensive to cover the wide variations of surface tension exhibited by pathological urine, and so we have been obliged to employ the simple formula given above.

In order, however, to form some estimate of the possible errors hereby incurred we have determined the surface tension of a dried and refractionated specimen of monochlorobenzene at 9.5° C. According to Ramsay and Aston⁴ its density at this temperature is 1.1182 and its surface tension 33.7 (dynes per cm.). At a temperature of 9.5° C. the monochlorobenzene gave 481 drops. As a standard liquid we employed distilled water (ordinary tap water gave very nearly the same result). At the mean temperature of the measurements—namely, 16° C.—water gave 199 drops. Taking the surface tension of pure water at 16° as 73 dynes per cm. (according to Landolt and Börnstein's tables), and its density as sufficiently near unity for the present purpose, we get for the surface tension of monochlorobenzene:

$$\frac{100 \times 73 \times 1.1182}{481} = 33.8$$

This result agrees with the value determined by Ramsay and Aston. This is, moreover, an extreme case, since the drop ratio (number of drops of liquid ÷ number of drops of water) is here 2.4, whilst in the case of the urine determinations, where the number of drops varied from about 220 to 280 (in icteric urine), the mean drop ratio is only about 1.2. It may fairly be concluded, therefore, that the error in the latter case is very small. Probably one would be safe in allowing 0.1 per cent. as the maximum error involved. According to Duclaux, for a pipette giving 100 drops with water, there is no correction up to 140 drops. If the correction is chiefly a function of the drop ratio, then our pipette should require no correction up to 280 drops—that is, throughout the range in which it has been employed. This indicates that the allowance of 0.1 per cent. is probably an outside limit. This degree of accuracy is, however, amply sufficient for all purposes of clinical diagnosis, since normal urine, even under similar conditions, may exhibit variations of surface tension amounting to 4 per cent. (and sometimes much more).

After the present investigation had been planned and a considerable amount of experimental work carried out, we discovered a paper published by J. Amann⁵ in which the results of similar measurements are described. We have only, however, been able to see a brief abstract⁶ of this paper.

According to Amann, the surface-tension of normal urine is about 90 to 92 per cent. of that of water. The depression is said to be considerable in diabetes, nephritis, enteritis, and icterus, whilst in cases of anaemia the surface tension is slightly increased. In certain cases of "grave" anaemia the surface tension may, according to Amann, even exceed that of water. So far as we can interpret the brief abstract referred to above, the depression of surface tension is ascribed by Amann to "extractive substances."

We have not considered it necessary to discontinue this investigation owing to the publication of Amann's work, as in a new field such as the present the results of independent workers may supplement each other in important particulars.

2. APPARATUS AND METHOD OF MEASUREMENT.

The apparatus employed is shown in Fig. 1.:

Fig. 1.—Drop pipette with speed control and water-jacket. *a* is the dropping-pipette provided in its upper stem with a tap (*h*). The lower stem of the pipette passes through the rubber stopper, *b*, which closes the upper end of the glass cylinder, *c*. The latter is held firmly in the neck of the water-jacket, *d*, by means of the rubber stopper, *c*. By keeping the water in the jacket at the desired temperature the temperature of the liquid at the place where the drops detach themselves is as nearly as possible the same as the temperature of the water-jacket. The lower end of the pipette consists of a short piece of thin-walled truly cylindrical glass tubing of small bore sealed to the lower stem. We have not, however, made any experiments to ascertain whether this is the best form of orifice to employ.

Fig. 2.—Effect of bile salts on the surface tension of normal urine.

It is necessary that the drops should form slowly, and that the total time of outflow should vary as little as possible. This is effected by allowing the air which replaces the liquid in the pipette to pass through a very narrow capillary tube, *g*. It is easy to allow the walls of an ordinary piece of capillary

Fig. 3.—Chart showing rise of surface tension of urine during recovery from catarrhal jaundice.

tubing to nearly fall together in the blowpipe flame, and then to narrow the bore by pulling out somewhat. When a suitable tube has been prepared it can be simply fastened on to the L-piece by means of rubber tubing. As shown in the figure, the capillary tube is provided with a wider piece of tubing, *k*, containing cotton wool in order to prevent dust entering and blocking the fine bore of the capillary. In the experiments the time of outflow remained practically constant and amounted to ten minutes.

In making a determination, the procedure is as follows: The tube, *f* (shown on the right), is filled with the urine, and by means of the handle, *g*, is thrust up into the neck of the jacket, so that the orifice of the pipette is plunged well under the liquid in the tube. The taps, *h* and *i*, being open, the pipette is filled some distance above the upper mark by suction applied to the end of the rubber tubing, *m*. The taps, *h* and *i*, are then closed. After the liquid in the pipette has been given time to take up the temperature of the water jacket, the tap, *h*, is opened and counting begun as soon as the level of the liquid arrives at the upper mark on the stem of the pipette. Counting is most easily effected by having a supply of sheets of paper ruled into squares of convenient size. Every time a drop is heard or seen to splash into the beaker placed below the apparatus a mark is made in one of the squares. This simple arrangement obviates the use of any elaborate automatically registering apparatus, and enables the experimenter to determine the number of drops with very little fatigue. It is in general not necessary to make a duplicate determination, since the results are uniformly identical. Needless to say, it is highly important to wash the pipette once or twice with pure water (by sucking up water in the manner indicated) after making a urine determination.

Fig. 4.—Drop pipette for rapid measurements.

3. VARIATION OF THE SURFACE TENSION OF URINE IN HEALTH.

All the experiments were carried out at a mean temperature of 16° C. A variation of temperature amounting to one degree produces, however, a scarcely perceptible effect on the drop number, as the following experiments with distilled water show:

Temperature.....	16°	18°	20°	25°
Number of Drops..	199	200	201	202½

In all cases the surface tension is given as a percentage of that of pure water at 16° C. Thus in the case of a urine giving a drop number of 225 and a density of 1.021, we have:

$$\text{Surface tension} = \frac{100}{225} \times 1.021 \times 100 = 90.3 \text{ per cent.}$$

If we take as the surface tension of pure water at 16° C., the value 75 (dynes per cm.), it is only necessary to multiply the percentage numbers given by 0.75 to convert them to surface tensions expressed in dynes per cm. So far as our experiments go, the surface tension of the urine of apparently healthy individuals is subject to considerable fluctuations. This is illustrated by the following table. The urines examined were in every case the secretion during twenty-four hours of different individuals.

Density ...	1.026	1.026	1.022	1.016	1.033	1.018	1.017	1.025	1.017
Number of drops...	226	227½	223½	217	228	212	216	224	214
Surface tension ...	90.3	89.7	91.0	93.2	90.2	95.6	93.7	91.0	94.6

It will be observed that in the above cases a high surface tension is associated with a comparatively low density, whilst it will be presently shown that in certain cases where normal urine shows a low surface tension, this is usually associated with a relatively high density. Such variations are therefore to be ascribed to variations in the general concentration of the urine. In considering the surface tension of a sample of urine we must therefore take the density into consideration at the same time, as an index to the general degree of concentration of the urinary constituents.

In the case of samples which are not drawn from the total secretion of twenty-four hours, we may expect still greater variations. In order to investigate this point, and to determine the influence of other factors, the urine of a single individual was examined from time to time during over a fortnight. The man in question was taking very little exercise throughout this period, except on one occasion when a ten-mile walk was undertaken in order to ascertain the effect produced (this is indicated in the results by the letter E).

Date.	Time.	Density.	Number of Drops.	Surface Tension.
August 9	5.30 p.m.	1.016	224	91.1
" 10	Morning*	1.020	235	87.1
" 15	"	1.027	247	82.7
" 15	4.30 p.m.	1.021	217	93.6
" 16	Morning	1.027	244	83.8
" 16	4.15 p.m.	1.024	222	91.8
" 17	Morning to night	1.016	217	93.2
" 22	" "	1.033	242	84.9E
" 23	Morning	1.035	250	82.4
" 24	Morning to night	1.033	228	90.2
" 27	"	1.025	224	91.0
" 28	Morning	1.033	248	82.9

* That is, after sleep.

The morning urines are uniformly characterized by a high density and low surface tension, both of which effects are probably to be ascribed to a considerable concentration of the morning urine. This effect may be absent, or not so pronounced, in other individuals, as the following results of measurements of the morning urines of several other persons show:

Density ...	1.023	1.015	1.025
Drop number ...	224½	210	233
Surface tension ...	90.7	96.2	87.5

The effect produced by unusual exercise is interesting. There is a great fall in surface tension, and this is accompanied by a rise in density corresponding to the concentration of the urine produced by the exercise (that is, due to perspiration, etc.). The results of August 24th show, however, that a high density is not necessarily associated with a low surface tension.*

It is clear that the urine of apparently healthy individuals may exhibit considerable variations of surface tension. In considering the surface tension from a diagnostic point of view, attention must be paid simultaneously to the density, the time of day at which the urine was passed, and possibly to various other factors, such as amount of exercise, etc. If a sample drawn from the total secretion of twenty-four hours cannot be obtained, it would be well to avoid morning urines.

* All the urines examined were tested for the presence of sugar and albumen, both of which were absent.

The question naturally arises as to what are the constituents which cause the surface tension of normal urine to be about 10 per cent. lower than that of water. This effect cannot be due to any of the inorganic salts, since these are known to increase the surface tension of water. Nor is the effect due to urea or urates, as the following results show:

Effect of Urea on the Surface Tension of Water.

Grams Urea in 100 c.cm.	Density.	Drop Number.	Surface Tension.
0	1.000	199	100.0
3	1.008	200½	100.0
6	1.012	201	99.7

It was thought at first that the low surface tension of the morning urines might be due to an increase in the concentration of urea. The results of the experiments made to test this hypothesis given in the table show that variations in the concentration of urea have practically no effect:

	Density.	Drop Number.	Per Cent. Urea.
Urine A (afternoon)	1.021	217	1.8
Urine B (morning)	1.027	244	3.5
Urine A + enough urea to make it 3.5 per cent.	1.024	217	3.5

In order to test the effect due to urates, 0.33 gram of sodium urate (from E. Merck) was dissolved in 100 c.cm. of water. The density of this solution was 1.0025 and its drop number 199½. Its surface tension is therefore practically the same as that of water. We have not been able to pursue this matter any further, although the question is one of great interest.

The property of lowering the surface tension of water when present in relatively small concentration is not by any means a common one. Besides the soaps and the bile salts, the higher aliphatic alcohols and acids are known to possess this property in a marked degree.

Not having been able to gain access to his paper, we do not know whether Amann has been able to ascertain the actual chemical nature of the substance or substances which produce the depression of surface tension in normal urine. In the abstract quoted above he refers to them as extractive substances, but this term is one which might cover a great number of different bodies.

Until, however, we know the exact nature of the effective substances and their origin, it will be difficult to interpret the variations of surface tension observed under apparently normal conditions. This uncertainty, moreover, diminishes the value of surface tension observations as an aid to diagnosis in pathological conditions. An exception must, however, already be made in the case of jaundice, where a definite connexion between the surface tension of the urine and the presence of certain pathological constituents has been established.

4.—INFLUENCE OF PATHOLOGICAL CONSTITUENTS ON THE SURFACE TENSION.

In order to ascertain the effects due to the presence of the more commonly-occurring pathological constituents we have carried out experiments in which known amounts of these substances were added to normal healthy urine.

Sugar.—A sample of pure fused dextrose (Kahlbaum) was employed. The results obtained are recorded in the following table:

Influence of Dextrose.

Per Cent. sugar.	Density.	Number of Drops.	Surface Tension as per Cent. of that of Pure Water.
0.00	1.026	223	89.5
3.26	1.038	220	90.2
4.87	1.044	230	90.3
10.33	1.066	233½	90.8

The effect of the dextrose is very slight, tending to increase the surface tension. So far, therefore, as the presence of sugar is concerned surface-tension measurements are not characteristic of pathological conditions.

Bile Salts.—In cases of ordinary (obstructive) jaundice these salts

enter the blood stream and thence find their way into the urine, where they produce a very marked depression of surface tension. It is a matter of interest, therefore, to ascertain the effect produced by the addition of these salts to normal urine *in vitro*. The following results show the enormous effects produced by extremely small concentrations of these salts, and enable one to form some estimate of the percentage of bile salts contained in icteric urine.

Sodium Taurocholate.—Specimen obtained from E. Merck:

Effect Produced by Sodium Taurocholate.

Per Cent. Taurocholate.	Density.	Number of Drops.	Surface Tension as per Cent. of that of Water.
0.00000	1.026	227	89.9
0.00165	"	233	87.6
0.00495	"	244½	83.5
0.00990	"	257	79.4
0.01650	"	268	76.2
0.01980	"	272	75.1
0.03300	"	286	71.4
0.04950	"	297	68.7
0.05250	"	312½	65.3

Sodium Glycocholate.—From E. Merck. Different specimen of urine:

Effect Produced by Sodium Glycocholate.

Per Cent. Glycocholate.	Density.	Number of Drops.	Surface Tension as per Cent. of that of Water.
0.00000	1.022	223½	91.0
0.00166	"	235½	86.4
0.00498	"	255	79.8
0.00996	"	277	73.4
0.01660	"	295	68.9
0.03320	"	307	66.2
0.06640	"	326	62.4

These results are shown graphically in Fig. 2, in which the ordinates represent surface tensions as percentages of that of water, whilst the abscissae represent the concentrations of the bile salt in thousandths of 1 per cent.* The glycocholate acts more powerfully than the taurocholate. It must be stated, however, that the glycocholate employed did not appear to be quite free from pigment, as a stock solution made up from it (2 grams in 100 c.cm.) had a rather brownish colour. The solutions of glycocholate in urine were also rather cloudy. This may possibly have been due to a slight separation of glycolic acid, caused by the acidity of the urine.

It will be seen from the cases recorded below that the highest drop number observed (in a case of deep jaundice) was 295. Recollecting that human bile contains a much greater proportion of glycocholate than taurocholate, and assuming that the variation of the surface tension from the normal is principally due to the presence of bile salts, we may estimate the proportion of bile salt present in the urine as about two-hundredths of 1 per cent. Although this estimate cannot make any pretension to accuracy, it is quite certain that it is correct, so far at any rate as the order of magnitude is concerned. This result explains the difficulty of isolating and estimating the bile salts in icteric urine by chemical methods. The effect produced by the addition of filtered ox gall to normal urine may be illustrated by an experiment made in the earlier part of this investigation. The drop number only, and not the surface tension, is given, since the time of outflow varied somewhat owing to the deficiencies of the form of speed-control originally employed.

Effect Produced by Filtered Ox Gall.

C.cm. Cholic Fluid in 100 c.cm. Solution.	No. of Drops.	Density.
0.00	215	1.023
0.04	225	
0.10	239	
0.20	255	
0.40	275	
0.60	288	
1.00	297	1.025
1.80	308	1.026

The results are similar to those produced by the bile salts alone.

* Both curves are referred to a urine whose surface tension is 90 per cent. of that of water.

The effect produced on the surface tension by the bile salts is very similar to that caused by the alkali salts of the higher fatty acids—that is, by the soaps. It is very probable that one of the physiological functions of the bile salts is to exercise an emulsifying action on the fats contained in the intestine, similar to the well-known emulsifying action produced by the soaps.

It would be very interesting if determinations could be made of the variation of the surface tension of blood serum in cases of jaundice. Although the concentration of the bile salts in the blood will doubtless be very much lower than in the urine, it is possible that the amount in the blood is sufficient to lower its surface tension in a marked manner. It might be supposed that such an effect would materially alter or derange some of the secretory or other processes in which the blood is concerned. The presence of an emulsifying agent in the blood might also be expected to cause unusual effects.

Acetone.

As acetone occurs in the urine under certain conditions, a few determinations have been made with this substance, as recorded in the table below:

Per Cent. Acetone by Volume.	Number of Drops.	Density.	Surface Tension as per Cent. of Water.
0.0	227½	1.0020	91.0
0.4	226	1.0215	89.9
1.0	230	1.0210	88.3

Addition of acetone lowers the surface tension, but the effect is not very marked unless about 1 per cent. by volume of acetone is present.

Albumin.

We have not made any experiments with blood proteids, but as all proteid substances exist in a state of pseudo or colloidal solution, it is highly probable that they all behave alike in respect of producing little effect on the surface tension. That this is true for the proteids of egg-white is shown by the following results:

	Number of Drops.	Density.	Surface Tension.
Normal urine	219	1.025	93.1
100 c.cm. + egg-white*	221	1.024	92.2
100 c.cm. + same volume of distilled water	214	1.016	94.5

* The amount added measured exactly 1 fluid oz.

Although the addition of the egg-white not only dilutes the normal urinary constituents, but adds inorganic salts as well as proteid, the results clearly demonstrate that the effect produced by a large amount of proteid is relatively small. The conclusion appears justified that the surface tension affords no certain indication of the presence of serum proteids.

It would be interesting to extend this inquiry to other less commonly occurring pathological constituents, such as the amino-acids (leucine and tyrosine), aceto-acetic acid, lactic acid, beta-oxybutyric acid, etc. It is possible that the result of such an inquiry would be the discovery of pathological constituents other than the bile salts, which produce in small concentration a marked effect on the surface tension of urine.

5. SURFACE TENSION OF URINE UNDER PATHOLOGICAL CONDITIONS.

In all cases of catarrhal jaundice so far examined, the surface tension of the urine has been found to be abnormally low and to rise progressively to the normal value as the jaundice passes off. The results obtained in a number of such cases are recorded in the following table.

The progressive rise of surface tension during recovery (see Case E in table) is illustrated by the accompanying chart (Fig. 3). It is clear that in all the cases quoted above, bile salts were present in the blood during the icterus, and that their disappearance occurred *pari passu* with the disappearance of the jaundice. In cases of so-called non-obstructive jaundice ("toxaemic jaundice"), bile salts are said to be present in very diminished quantity. A careful examination of the surface tension of the urine in such cases would be very interesting, but during the progress of this work we have not had any opportunity of examining such cases. An examination of the curves given in Fig. 2 shows that the surface tension method

is particularly suitable in cases of this sort, since owing to the steepness of the curves near the origin, very small quantities of the bile salts produce a marked effect.

Surface Tension of Urine in Cases of Ordinary Catarrhal Jaundice.

	Density.	Number of Drops.	Surface Tension (Percentage).
A.	1.023	277	73.5
B.	1.020	274	74.1
.. Several days later. Now non-febrile, but skin still yellow	1.017	260	77.8
C. Temporary jaundice (slight)	1.022	242	84.0
D. Severe	1.015	295	69.1
.. Two days later	1.021	284	71.5
.. Jaundice gone	1.006	208	95.2
E.	1.022	270	75.3
.. Two days later	1.030	263	77.9
.. Two days later. Bile in motions, tongue clear, and patient better	1.013	235	85.8
.. Three days later. Jaundice quite gone	1.027	225	90.8
F. Incipient jaundice	1.015	248	81.4
.. Several days later	1.020	272	74.6
.. Jaundice gone	1.019	215	94.3
G. Evanescent jaundice	1.018	250	81.0

With regard to other diseases, our observations are scarcely sufficiently numerous to permit of definite conclusions. Owing to the statements attributed to Amann in the abstract alluded to above, we have examined, amongst others, one or two cases of diabetes and of pernicious anaemia, but have not so far observed any very definite effects. It is to be hoped, however, that those who have the resources of a large hospital at their disposal will continue these observations. The tracing of a definite connexion between the surface tension of the urine and other morbid conditions would have considerable value, owing to the ease with which measurements of surface tension can be made. The following table contains some of the determinations referred to above:

	Density.	Number of Drops.	Surface Tension (Percentage).
A. Diabetes mellitus, sugar 4 per cent.	1.030	226	90.7
B. Gouty glycosuria, sugar 5.2 per cent.	1.027	217	94.2
C. Albuminuria	1.020	248	81.8
D. Pernicious anaemia	1.016	231	87.5
E. Suspected pernicious anaemia	1.010	216	93.0
F. One month later	1.016	241	83.5
F. Papilloma of ovary and phthisis	1.017	228	88.8

6. PIPETTE FOR RAPID CLINICAL MEASUREMENTS.

For the purposes of rapid work in which the object is rather to detect the presence of abnormal conditions than to make a determination of surface tension, we have employed the small portable pipette shown in Fig. 4. To the lower stem is sealed a capillary tube of about 1 mm. inner bore. In its upper portion the bore of the capillary is sufficiently constricted to reduce the speed of outflow to a convenient value. The pipette shown in the figure contained about 5 c.cm., giving with water at ordinary room temperature 59 drops in eighty seconds. It is unnecessary to have a mark on the lower stem, as the dropping ceases when the level of the liquid reaches the constriction in the capillary. The following table shows the results of some comparisons between the portable pipette and the one used in this investigation:

Urine Employed.	Number of Drops.	
	Portable Pipette.	Fixed Pipette.
Normal	65	227½
Icteric	72	242
"	78	277
"	77	260

Although there is not complete quantitative agreement between the two sets of results, it is clear that the small

pipette can be safely relied on to indicate an abnormally low surface tension with certainty, and to give an approximate idea of its value. As the pipette is of exceedingly simple construction and only measures a few inches in length, whilst the test can be carried out in a minute or two, it ought to prove of service as a convenient quantitative substitute for Hay's test.

In conclusion we have great pleasure in expressing our thanks to Mr. J. J. Macaulay, M.P.S.I., for valuable assistance rendered to us on several occasions.

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REMARKS ON A CASE OF DETACHMENT OF THE RETINA.*

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THE case of retinal detachment which I propose to report to you is, I think, one of considerable interest. The treatment of detachment of the retina is, unfortunately, one of the most unsatisfactory in the whole range of ocular therapeutics, and the most diverse views are held by ophthalmic surgeons as to the value of different lines of treatment. While on the one hand some, and these mainly, I believe, Continental surgeons, persistently attack all cases of this affection coming under their notice by bold surgical measures, and are able to publish results which are on the whole encouraging—namely, results which go to show that in some cases the detached portion of retina can be restored to its original position, and kept there with a partial restoration of vision—there are others equally eminent who hold the most gloomy views as to the value of operative treatment, and even assert that they have never known a case where operative measures have effected a lasting cure. Some, indeed, condemn as specially inefficient the measures to which I attribute the success of this particular case, and in this connexion I may here point out that these measures were undertaken only after milder methods had been tried and had failed.

The case differs in some very important respects from the majority of those which have been reported. The chief points of difference are, first, the early recognition of the condition, which was effected before the central vision was impaired, which rendered possible the second, namely, that the patient still has full vision—that is, $\frac{6}{6}$. Most of the results which I have seen reported have been secured in patients whose vision had already been much impaired by the detachment and in whom recovery had necessarily been only partial.

The patient, H. A., came to me in July, 1903, complaining of an uncomfortable sensation in his left eye, which he described as being like the shimmer of strong light off the surface of moving water. This had been going on for three weeks previous to his coming to me, and as his sight in both eyes was quite good he did not attach any great importance to it, and, indeed, rather apologized for his visit, which he seemed to think was hardly necessary. There were no other symptoms and the vision in the eye was quite good.

On examination of the affected eye the field of vision was found to be defective below—namely, from a point 20 degrees from the fixation point to the periphery. Central vision was unaffected, the patient reading with full correction $\frac{6}{6}$. Examinations of the fundus revealed the presence of a clearly-marked detachment of the retina in the upper quadrant.

As regards the question of causation in this case, the patient had a myopia in the right eye of 9 D., with a slight astigmatism, and in the left (the affected eye) a myopia of 8 D. Myopia is, of course, the commonest predisposing cause of retinal detachment, but another possible factor in the case was the participation by the patient in a "tug-of-war" a week or two previously. Whether the strain involved in this severe physical effort was instrumental in actually determining the detachment must, I suppose, be doubtful.

The condition of affairs, with its very unfavourable prognosis, was communicated to the patient, and the possibility of cure by energetic treatment was offered. Although I was not at all sanguine of success, I felt that this was a case where there were many circumstances in the patient's favour. He was a young and healthy subject; the detachment was obviously recent, and there was no evidence of other intra-ocular disease. And I was encouraged to adopt active measures the more as the patient, who was of a highly-intellectual type, fully realized the gravity of the situation, and was plucky enough to face all the rigours of what promised to be rather drastic treatment, with only a faint hope of ultimate success.

He was admitted to a private nursing home and treatment was begun. The dorsal decubitus was instituted and rigidly adhered to, and in view of the possibility of cure by mild measures only, I tried a course of daily subconjunctival injections of 2 per cent. saline and diaphoresis by daily hypodermic injections of pilocarpine of gr. $\frac{1}{4}$. At this time he was seen by my colleague, Dr. J. W. Browne, in consultation, as I was anxious that no doubt should exist in the patient's mind as to the need for what he had found by this time to be very irksome treatment. Dr. Browne's opinion coincided with my own—that the case was one for active treatment, and that if the injections, diaphoresis, etc., failed, puncture might be tried.

At the end of a week no improvement had taken place. I then decided to perform evacuation of the subretinal fluid by scleral puncture, and effected this without much difficulty, using for the operation an ordinary iridectomy knife. The immediate effect was all that could be desired. The subretinal fluid came away freely, and examination of the eye immediately afterwards with the ophthalmoscope showed the originally grey detached retina back in position with its pink colour restored, the subjective sensation of a grey veil simultaneously disappearing. I followed the puncture by another subconjunctival injection and bandaged the eye firmly with a pressure bandage.

In four days, however, the retina again became detached, with return of the subjective phenomena, and I decided again to puncture and, in addition, to apply the galvano-cautery over the seat of operation, with the intention of setting up enough adhesive inflammations of the parts to fasten down the retina. This was done on the twelfth day from the institution of the treatment, and again the immediate effect was completely successful. For eight days after this the retina remained in position, and again the detachment recurred.

At this stage the patient was seen in consultation by my colleague Dr. Nelson. He considered that the former results of the operation had been so favourable as to justify a repetition of the procedure, and this was again done, now near the end of the fourth week from the beginning of the treatment. On this occasion I first dissected back a flap of conjunctiva in order to allow the puncture to be made so far back as possible, and the cautery was energetically used.

After this no signs of detachment again returned. As a precautionary measure, however, I thought it advisable to again apply the cautery at the end of a week in order to cause further inflammatory adhesions. On testing subjectively it was now found that there was a relative colour scotoma in that portion of the field corresponding to the seat of the detachment, that is to say, that colour sensations as determined by a blue test object were, according to the degree of illumination, confused or quite lost over this area, although the object itself could be seen.

Examination of the fundus showed slight opacity and one or two punctate deposits of exudate in the affected portion of the retina. The normal pinky appearance was, however, quite restored. More peripherally the position of the punctures and cauterizations could be easily seen as a deeply-scarred and pigmented surface.

The dorsal position was maintained for ten days further and then the patient was allowed to go home. Three weeks later the condition was still found quite satisfactory, central vision (corrected) being $\frac{6}{6}$, and the only visual defect being a relative colour scotoma over an area of the field extending from the 30th to 60th degree in the lower half. On November 16th this scotoma had so improved that the patient could appreciate colours, but blue appeared darker. The patient was last seen by me in April, 1905—that is, twenty months after the termination of treatment. Vision was still $\frac{6}{6}$, and no sign of detachment could be detected. I would call special attention to the following points in this case:

* Read at a meeting of the Ulster Branch of the British Medical Association.