to filter urines which are turbid. With albutix a positive result is indicated by a colour change; this is easier to assess than the change in turbidity obtained with the precipitation tests for proteinuria.

It is important to consider the sensitivity of albutix in comparison with other tests for proteinuria. It is generally agreed that normal subjects may excrete up to 50 mg. of protein in 24 hours (Rigas and Heller, 1951). In view of this, Fishberg (1954) has given as an acceptable definition of proteinuria: "When protein is present in urine in amounts sufficient to be detected by ordinary clinical tests which . . . are not sufficiently sensitive to detect normal amounts." The clinical tests for proteinuria (boiling, salicylsulphonic test) are generally accepted as sensitive to 5–10 mg. of protein per 100 ml. of urine when properly performed (King, 1951; Baron and Oakley, 1957; Rice, 1957). If albutix could be shown to detect 5–10 mg. per 100 ml. it would be acceptable as a clinical test for minimal proteinuria.

We have, in fact, found that albutix always gave a colour change with 5 mg. of protein per 100 ml. of urine, although the degree of colour change was often very slight. It may therefore be considered to have the sensitivity required. Unfortunately there was an appreciable proportion of apparent weak false-positive results with albutix. That these were false-positive results and were not due to physiological traces of protein is inferred by the observation that the same change in colour occurred with albutix before and after the removal of all protein by ultrafiltration. (We have not investigated the possible causes of the false-positive results.) A colour-change with albutix indicating less than 30 mg./100 ml. is therefore not specific for protein. If it is required to demonstrate proteinuria of less than 30 mg./100 ml. it is necessary to perform a salicylsulphonic acid or boiling test on urines giving these slight colour changes to verify the presence of protein.

The lowest protein concentration which is designated by the manufacturers on the colour scale is 30 mg./100 ml., and a colour change with albutix indicating a protein concentration of 30 mg./100 ml. or more always means proteinuria.

In the concentrations above 300 mg./100 ml. quantitation is unreliable. We feel that the colour scale should be modified to give four readings: "negative," "trace," "positive," "strong positive." These are respectively equivalent to protein concentrations of 0, approximately 30, approximately 100, and above 300 mg./100 ml.

In contrast to the salicylsulphonic acid test, albutix does not give false-positive results with urines containing radio-opaque materials or tolbutamide. This last fact may make albutix especially useful in diabetic clinics where patients are being treated with tolbutamide.

In view of these observations we make the following recommendations. Albutix is a convenient and reliable test for use by general practitioners, by nurses, and in large clinics when it is inconvenient to perform the boiling or salicylsulphonic acid test with sufficiently critical technique to ensure the highest sensitivity. Albutix provides a satisfactory test if unequivocal demonstration of minimal proteinuria is not required. The standard tests are preferred for laboratory use, except for screening.

In "albutest" the same principle is used in tablet form. An evaluation of this product has been made by Leonards (1957) and Rice (1957), both workers claiming that albutest could detect levels of 20 mg./100 ml.

Summary

A new manufactured colorimetric test for proteinuria, which involves dipping a prepared strip (albutix) into urine, has been investigated. The test is simple and convenient.

Colour changes were always obtained with specimens of urine containing 5 mg. of protein per 100 ml. or

more. Slight false-positive colour changes were sometimes given by protein-free urines. Colour changes indicating protein concentrations of 30 mg./100 ml. or more were specific for protein.

The test is roughly quantitative within the range 50–300 mg./100 ml. The clinical applications of this test are discussed.

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LABORATORY TRIAL OF A PAPER STRIP TEST FOR PROTEINURIA

BY

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A recent test for proteinuria employs impregnated paper sticks ("albutix") which remain yellow when dipped in normal urine but become green or blue if the urine contains protein. A five-step colour scale is provided, said to correspond to 0, 30, 100, 300, and 1,000 mg. of protein per 100 ml. of urine. The strips contain citrate buffer, pH 3 approximately, and an indicator, tetrabromophenol blue (tetrabromophenoltetrabromsulphonphthalein). The test is based on the so-called "protein error of indicators" and is not related in principle to either the heat-coagulation or the sulphosalicylic acid test for urinary protein.

Existing tests for urinary protein, although reliable and sensitive when carefully applied, are inconvenient to use outside the laboratory or consulting-room, particularly if a turbid urine requires filtration before the tests can be applied.

The new test, which requires no apparatus whatever, has obvious advantages in speed and simplicity. Since, however, it is based on an alteration in the effective pH range of an indicator, it was thought possible that differing conditions of pH, concentration, and buffering capacity of urine might cause some variation in the results of the test. The strips were therefore tested on a number of natural and modified urines in order to assess sensitivity and reproducibility, while normal and protein-containing urines were artificially varied in respect of pH and buffering capacity in order to assess the likelihood of errors from these sources.

Sensitivity and Accuracy of Calibration

Twelve protein-containing urines were each diluted with normal urine until they gave apparently negative indications with albutix, and these diluted urines were then tested for

protein by the heat-coagulation and sulphosalicylic acid tests (Harrison, 1957). All gave a faintly positive reaction to both tests, implying that albustix is slightly less sensitive than the conventional tests.

Plasma of known protein content was added to normal urines to give a range of protein concentrations from 0 to 2,000 mg./100 ml., and strips were dipped and compared with the colour scale. Positive reactions, with a continuous gradation of colour from pale green to blue, were obtained over the range of from 30 to 600 mg./100 ml.; at concentrations less than 30 mg./100 ml. some urines gave negative reactions, while with others the test strips became pale green in patches, the remainder of the strip remaining yellow. At concentrations in excess of 600 mg./100 ml., the maximum (blue) colour was obtained. Although the colour gradation was continuous over the intermediate range of protein concentrations, difficulty was found in matching the strips with certainty against any one step on the colour scale, and it appeared more satisfactory to record the results as "negative," "trace," or "positive," without attempting more precise assessment.

A series of albustix strips were dipped into protein-containing urines, and the estimated protein content, as judged by the colour scale, was recorded. The protein content of the urines was also determined by the micro-Kjeldahl procedure. The results are shown in the Table. Although an appreciable discrepancy appeared in the case of urines 2 and 4, the difference is equivalent to one step of the colour scale and is not likely to be clinically significant.

Protein Content (mg./100 ml.)

		Urine No.							
		1	2	3	4	5	6	7	8
By Kjeldahl	..	75	830	350	140	65	145	210	810
„ albustix	..	100	300	300	30	100	100	300	1,000

Reproducibility

Strips were taken at random from five packages, and were dipped simultaneously into urine containing 200 mg. of protein per 100 ml. The colours were compared immediately and again after 2 minutes. No differences between strips were noted, and the colour had not darkened appreciably after 2 minutes.

The effect of variations in the manner of dipping was studied by dipping one-quarter, one-half, and the whole of the impregnated portion of several strips, for periods of 2 seconds, ten seconds, and 2 minutes, into normal and protein-containing urine. Considerable differences were observed. In particular, partial immersion was found to give patchy and erratic results, while total immersion for 2 minutes or more in protein-free urine gave occasional false-positive indications. When strips were quickly and completely dipped, removed at once, and drained by touching against the side of the vessel the colours were uniform and false-positives did not arise. These effects seem to be due to partial or complete elution of the citrate buffer from the strip, thus allowing the indicator to respond to the normal pH of the urine.

Effect of Urine pH

The indications given by albustix with naturally acid urine, pH 5.2, and naturally alkaline urine, pH 7.5, to which protein had been added to give a concentration of 200 mg./100 ml., were compared. A similar comparison was made when 30 mg./100 ml. had been added. In each case the alkaline urine gave a more positive indication, but the difference (less than one division of the colour scale) was insignificant.

Urine containing 200 mg. of added protein per 100 ml. was titrated with 5N HCl over the pH range from 7.5 to 1.5, as measured by the glass electrode, and the reaction with albustix was noted at steps of 0.5 pH unit. The colour

progressively lessened with increasing acidity, and became "negative" at pH 2.5. The change in colour over the physiological pH range (5–7.5 approximately) was negligible, but the addition of acid to urine—for example, as a preservative—will result in false-negative reactions.

Protein-free urine was titrated with ammonium hydroxide in a similar manner over the range from pH 5 to 9.5. An apparently positive reaction for protein appeared at pH 9.5 in one instance, and at pH 9.1 in another—that is, well above the physiological limit of urinary alkalinity.

Stale urine, pH 9.2, and having a perceptible odour of ammonia, was centrifuged free of suspended particles. The supernatant contained no protein by the sulphosalicylic acid test, but gave with albustix an indication corresponding to the maximum colour on the scale. When this urine was brought to pH 7 by the addition of HCl, a negative reaction was obtained, confirming that the false positive was due to excessive alkalinity.

Effect of Urine Concentration and Buffering Capacity

Although a number of naturally concentrated protein-free urines, with S.G. from 1025 to 1030, gave negative reactions with albustix, it was thought desirable to investigate whether high concentration and high buffering power could combine to give false-positive reactions.

The buffering capacity of protein-free urine was increased by the addition of solid sodium dihydrogen phosphate and disodium hydrogen phosphate, varying the proportions added in order to bring the final pH to 5, 6.5, or 7.5. At pH 5, urine saturated with sodium phosphate gave a negative reaction with albustix. At pH 6.5, saturation with phosphate resulted in a positive indication, but dilution to half-saturation restored a negative reaction. At pH 7.5, half saturation with phosphate gave a faint positive result, while the reaction at full saturation was definitely positive.

Saturation of normal urine with urea resulted in a positive reaction equivalent to 100 mg. of protein per 100 ml., presumably due to interaction between urea and the citrate buffer.

The concentrations of phosphate or of urea required to produce these false-positive indications are, of course, considerably in excess of any which could occur naturally. To study the effect of a possible combination of high buffering capacity, high urea concentration, and high natural alkalinity, a synthetic "urine" was prepared containing 2.5% w/v sodium chloride, 5% w/v urea, and 2.5% w/v disodium hydrogen phosphate anhydrous. This solution, pH 8.4, gave a just-perceptible positive reaction with albustix, but when brought to a physiological pH of 7.5 the reaction became negative. It therefore appears unlikely that extreme levels of physiological concentration and pH could give rise to false-positive reactions, and such a fallacy has not so far been encountered in natural urine.

Possible Fallacies

From the nature of the reaction it appeared unlikely that pathological urinary constituents, other than proteins, could give a positive response, and the reactions of the strips were found to be unaffected by the presence of bile salts, glucose, acetone, salicylates, sulphonamides, or iodide. Toluene, used as a preservative, caused some difficulty, in that if the strip became saturated with toluene it became water-repellent and failed to react.

The presence of blood in visible amount gave a positive reaction for protein, but microscopic haematuria did not give a positive reaction.

Freshly passed urines occasionally gave a reaction equivalent to 30 mg./100 ml. or less, which was not obtained after a mucous cloud had settled out. Mucoprotein, as one would expect, gives a positive reaction, and for this reason it appears inadvisable to use the strip by touching it to the urine as it is passed, at least so far as the first few drops of urine are concerned.

Prostatic "threads," and flakes of epithelial debris in female urine, were found to give locally positive reactions if caught on the test strip.

Stability of the Strips

After four hours' exposure in an air oven at 100° C. the strips showed no difference in sensitivity or colour reaction. Exposure to laboratory air for 24 hours produced pale-blue discoloration, apparently due to ammonia; but, surprisingly, such strips reacted normally to urine. Similarly, prior exposure to HCl fumes apparently caused no permanent damage. Brief exposure to steam or dipping in water did not interfere with subsequent indications, although more prolonged steaming, or washing in running water, resulted in subsequent false positives due to removal of the citrate buffer. For the same reason it appears inadvisable to attempt to use a strip to test more than one urine.

Conclusions

Albustix is a simple and speedy test for proteinuria, and, although less sensitive than the present tests for urine protein, it appears to be adequately sensitive for routine use.

Variation of urine acidity or alkalinity within physiological limits does not interfere with the results qualitatively, but it slightly affects the quantitative indication.

Gross alkaline fermentation of urine can lead to spurious positive indications, while the addition of acid or toluene as preservatives can lead to false-negative reactions. Natural variations of urine concentration and buffering capacity are unlikely to be sources of error.

Consistent results are dependent on the impregnated portion of the test-strip being completely immersed and quickly removed from the urine. The strip should not be left in urine for subsequent inspection.

False-positive reactions due to non-protein substances have not so far been encountered.

Semi-quantitative recording of results is not recommended, apart from a rough classification such as "negative," "trace," or "positive."

I am grateful to Dr. C. P. Stewart for suggestions and criticisms, and to Mr. D. H. Vobes, of Ames Company (London) Ltd., for a generous supply of albustix, and for information on its composition and mode of action.

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On the purchase of hospital equipment, the relevant advisory committee of the British Standards Institution writes: "The B.S.I. enjoys the support of the Ministry of Health in encouraging the purchase by hospitals of equipment conforming to British Standards. At the same time, it is the policy of the Ministry to allow Boards of Governors and Management Committees a good deal of autonomy in the selection of the goods they buy. In consequence there are manufacturers who have co-operated in producing British Standards who state that they rarely receive inquiries for equipment complying with them; on the other hand, hospital officials point out from time to time that they have difficulty in obtaining quotations. Undoubtedly this situation is to a large extent created by tradition and conservatism, manufacturers and users alike preferring to continue, in many cases, with the sale and purchase of commodities to which they are accustomed. There is, moreover, a disappointing lack of awareness that most standards provide alternative types or optional features."—*Fourth Report of the Hospital Equipment Standards Advisory Committee* (February, 1958), obtainable free of charge from the British Standards Institution, 2, Park Street, London, W.1.

LICHEN PLANUS OF THE MOUTH

BY

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The purpose of this paper is to draw attention to lichen planus presenting as a disorder of the oral mucous membrane with minimal or no cutaneous eruption. Forty-five cases are described.

It is well recognized that lesions in the mouth can often be demonstrated in cases of cutaneous lichen planus. Samman (1956), in a series of 121 cases, recorded mouth lesions in 77%; and, of 227 cases of lichen planus seen in the United Bristol Hospitals from 1949 to 1956, mouth lesions were present in 51%. However, it does not seem to be generally realized that lichen planus can occur in the mouth without any cutaneous eruption.

Present Series

During the period 1950-7, 45 patients presenting with mouth lichen planus have been seen by us, 19 being referred to the Dental Hospital and the remainder to the dermatological out-patient department. It is difficult to assess the real incidence, since our special interest in the condition may have attracted some cases which otherwise would not have been referred. The distribution of new cases seen during the period 1950-7 was as follows:

1949	..	2	1952	..	5	1955	..	7
1950	..	3	1953	..	4	1956	..	8
1951	..	3	1954	..	8	1957 (first		
						six months)		5

During this period the incidence of cutaneous lichen planus in the same clinical area showed no corresponding rise. Of the cases referred to the dermatological out-patient department, 11 were sent to our colleague, Dr. C. D. Evans, and 15 to one of us (R. P. W.). There is therefore evidence of moderate bias, but, on the other hand, some of the mouth cases may well have been treated by general surgeons, physicians, or dental surgeons, whereas most cases of lichen planus of the skin will be seen at dermatological out-patient departments. Thus for every case presenting in the mouth five or six cases of cutaneous lichen planus have been seen in the same period and clinical area, which gives a rough figure of comparative incidence.

The cases have been followed up at a combined dental and dermatological clinic held monthly. Eight have been observed for over three years; 5 for two to three years; 8 from one to two years; 11 from 3 to 12 months; and 13 on one occasion only. There were 30 females and 15 males. The age distribution was as follows:

3rd decade	..	4 cases	6th decade	..	17 cases
4th "	..	6 "	7th "	..	4 "
5th "	..	13 "	8th "	..	1 "

One patient's mother suffered from typical lichen planus confined to the mouth; it developed nine years after the onset in the daughter.

In six patients the condition was symptomless, the mouth lesions being noticed by the doctor or dentist. Twelve complained of roughness or dryness and two of a metallic taste. Thirty had pain at times which was associated with ulceration. Periods of dysphagia occurred in two patients—in one lesions were not noted on oesophagoscopy and the condition was thought by an E.N.T. surgeon to be globus hystericus, while in the other the symptom coincided with