

## THE ASSESSMENT OF THE VALUE OF A REAGENT STRIP IN TESTING CEREBROSPINAL FLUID\*

P. D. BECK, M.B., CH.B., Registrar AND C. R. RAINIER-POPE, † M.B., M.MED. (PAED.), D.C.H., Senior Paediatrician,  
Department of Paediatrics, Livingstone Hospital, Port Elizabeth

When doing a lumbar puncture, it is often useful to be able to examine the cerebrospinal fluid (CSF) at the time of the procedure. This is especially so in busy outpatient departments of hospitals and more so at night, or in country practices. Rapid handling of the patient or obtaining some idea of the diagnosis, without waiting many hours for the result, can speed up treatment considerably.

A rough qualitative estimate can be done by doing a Pandy's test for globulin and a boiling test with Benedict's reagent for the presence of glucose. This requires minimal apparatus and is no more cumbersome than doing a urinalysis. However, even urinalysis has now been simplified by the introduction of the various 'stix' by the Ames Laboratories. One of the newer in this line is the Hema-Combistix reagent strip, which combines 4 standardized colour tests for pH, glucose, protein and blood.<sup>1</sup> Though these strips have been primarily designed for testing urine, it was decided to see if results obtained in testing CSF with them, would be comparable with laboratory results. Their value in testing urine is now well established,<sup>2-10,12,13</sup> and there have been 2 papers<sup>14,15</sup> on the use of reagent strips in testing CSF. There have apparently been no reports on the use of a multitest strip in testing CSF.

### METHOD

CSF was obtained from 46 patients seen in the paediatrics outpatient department of the Livingstone Hospital, Port Elizabeth. These patients were referred for lumbar puncture for a variety of reasons; there was no selection of cases, the tests being more or less consecutive.

For this series, we were only interested in the protein and glucose reactions. The pH was not thought to be significant and was thus disregarded. Though it may be important to know whether blood is present or not, this was not analysed in all cases.

After taking the customary specimens for laboratory examination, the strip was held under the lumbar puncture needle, and the CSF allowed to run over it. The glucose and then the protein reactions were read according to the colour chart on the bottle. Glucose estimations had to be read 10 seconds after impregnation with CSF. Proteins were charted as: negative, trace, +(30 mg./100 ml.), ++(100 mg./100 ml.), +++(300 mg./100 ml.), ++++(over 1,000 mg./100 ml.). The glucose was charted as negative, light, medium or dark.

Laboratory examination of the CSF was carried out in the usual routine way, by the SAIMR, Port Elizabeth; quantitative results being given for sugar and protein.

### The Reagent Strip

The glucose test is a qualitative enzyme reaction, depending on the oxidation of glucose, catalysed by glucose oxidase, and then a chromogen reaction, giving a shade of purple. The test is sensitive to as little as 0.1% glucose and, being an enzyme reaction, is specific for glucose.<sup>2</sup> High levels of ascorbic acid or some antibiotics may inhibit colour development.<sup>11</sup>

The glucose test is strictly qualitative, whereas the protein test is broadly quantitative. The protein test depends on citrate buffered tetrabromophenol blue changing colour when protein is present.<sup>10</sup> Highly alkaline fluids may cause positive reactions, and the pH test colour should be checked.

\*Paper presented at the 45th South African Medical Congress (M.A.S.A.), Port Elizabeth, June - July 1965.

†Presently practising in Johannesburg.

### RESULTS

Forty-seven tests were performed on 46 paediatric patients. The results have been grouped according to the laboratory reports, into normal, abnormal and doubtful, depending on the protein level.

A protein below 40 mg./100 ml. was regarded as normal, and between 40 and 70 mg./100 ml. as doubtful. An excess of 70 mg./100 ml. was regarded as definitely abnormal.

The lumbar punctures were performed because of convulsions in 35, meningism in 5 and on suspicion in an ill child (with or without neurological signs) in 6 (Table I).

TABLE I. CSF RESULTS IN 46 CHILDREN

Reason for LP	CSF normal	CSF abnormal	Total
Convulsions	29	6	35
Meningism	2	3	5
Suspicion	4	2	6
Total	35	11 (24%)	46

Six of the 35 patients (17.2%) with convulsions only, had meningitis, 3 purulent, 2 tuberculous and 1 probably tuberculous. Of the 5 with meningism, 2 were normal (40%), while 1 had tuberculous meningitis, 1 pyogenic meningitis and in the third case the diagnosis was obscure. Of the 6 patients who were lumbar-punctured on suspicion, 2 were pathological and had tuberculous

TABLE II. PATIENTS WITH NORMAL PROTEIN VALUES

Number	Laboratory		Reagent strip	
	Protein	Glucose	Protein	Glucose
1	17	77	Trace	Med.
2	30	44	Trace	Dark
3	23.5	75	Trace	Dark
4	8.5	73	+	Dark
5	23	46.5	+	Dark
6	24.6	47	+	Dark
7	17.2	57	+	Dark
8	37	58.5	+	Dark
9	17	109	+	Dark
10	36.6	117.5	+	Dark
11	12.8	58	Trace	Dark
12	12.4	63	Trace	Dark
13	14	83	+	Dark
14	28	68	+	Dark
15	12.8	51	Trace	Dark
16	33	96	+	Dark
17	22	54	+	Dark
18	24	63	Trace	Dark
19	13	57	Trace	Med.
20	16	79	+	Dark
21	40	58	+	Dark
22	20	64	Neg.	Dark
23	11.2	60.5	Trace	Dark
24	17	10	Trace	Med.
25	39	71	Trace	Light
26	24.6	63	Neg.	Light
27	20	59.2	+	Dark
28	26.7	90	+	Dark
29	12.4	67.4	+	Dark
30	26.2	45	Trace	Dark

meningitis. The over-all abnormality was 11 out of 46 (24%).

There were 30 normal CSFs on the protein basis (Table II). In all instances the Hema-Combistix reaction was either negative (2), a trace (12) or + (16).

Five patients had CSF proteins between 40 and 70 mg./100 ml. (Table III) and thus were doubtful. However, in all these cases, the rest of the CSF examination, including cell counts, was normal. In these cases, the Hema-Combistix reaction showed a trace in 1 and + in 4.

TABLE III. PATIENTS WITH SLIGHTLY RAISED PROTEIN, BUT OTHERWISE NORMAL CSF

Number	Laboratory		Reagent strip	
	Protein	Glucose	Protein	Glucose
1	42	50	+	Dark
2	41.5	46.5	+	Dark
3	59	44	+	Dark
4	59	46	Trace	Med.
5	66	67.2	+	Light

Eleven patients (12 tests), had protein in excess of 70 mg./100 ml. (Table IV). In all instances the Hema-Combistix showed protein in excess of 100 mg./100 ml. (++) . There were 3 with ++, 7 with +++ and 2 were ++++. All these results corresponded very well with the quantitative results.

TABLE IV. PATIENTS WITH PROTEINS IN EXCESS OF 70 MG./100 ML.

Number	Laboratory		Reagent strip		Diagnosis
	Protein	Glucose	Protein	Glucose	
1	1,000	293	+++	Med.	TBM
2	139	24	to ++++	Dark	TBM
3	720	30.5	+++	Dark	TBM
4	184	4.85	+++	Neg.	Pur. men.
5	117	21	+++	Med.	Pur. men.
6	92	37.5	++	Dark	TBM
7	136	8.05	+++	Med.	Pur. men.
8	174	95	++	Med.	TBM
9	93	60	++	Med.	TBM
10	910	57.5	+++	Med.	Obscure
11	1,120	20	+++	Med.	Pur. men.
11(2)	232	27	+++	Med.	Pur. men.

Of the 35 patients that were regarded as normal, or doubtful on their protein levels, all except one had glucose in excess of 44 mg./100 ml. in their CSF. All (except 2 who had a light reaction), including the one with a low sugar, gave a medium to dark reaction on the Hema-Combistix. In the 2 exceptions, the quantitative sugar reactions were 71 and 63 mg./100 ml. respectively (Tables II and III). The reason why one patient with a normal protein and a medium reaction for sugar, had a quantitative level of only 10 mg./100 ml. is unexplained, though it may be suspected that it was due to delay in laboratory examination.

In the instances where the protein was elevated (Table IV), results with the glucose test were inconsistent, the quantitative test being much lower than the 'stix' reaction. In one instance of purulent meningitis, where the level was

8.05 mg./100 ml., a medium reaction was obtained whereas in a similar case, a negative reaction occurred when the sugar was 4.85 mg./100 ml. In 3 cases, a dark reaction occurred when the sugars were 24, 30.5 and 37.5 mg./100 ml. respectively.

#### DISCUSSION

The protein test with the Hema-Combistix correlated very well with the laboratory results and there were no falsely high levels. If anything, when the protein was only slightly raised in an otherwise normal CSF the Hema-Combistix gave a + reaction (30 mg./100 ml.). It can be thus stated, that for protein estimation, a very reliable idea can be obtained with the use of the 'stix'. This result is similar to that achieved with urine testing.<sup>10</sup>

The test for glucose was much less reliable, especially when there was a raised protein. It may be that protein potentiates the enzyme reaction, giving falsely high readings.<sup>11</sup> Also, the test is an extremely sensitive one, intended primarily for the detection of the smallest amount of glucose in urine. It would thus seem that as an estimation of even broad quantities of sugar in the CSF, the test is not reliable in the presence of high protein. If the protein is normal, a dark reaction will probably indicate a sugar content greater than 40 mg./100 ml. A negative reaction for sugar will be indicative of an extremely low sugar. In general, it would seem that the glucose reaction can only be used to indicate whether sugar is actually present or absent.

The time factor in reading the sugar estimation seems to be critical and open to error. The pH strip has a theoretical importance in protein estimation, but proved unnecessary in this instance as correlation was always reasonable. Also, large changes in pH of the CSF are unlikely. The presence of a haemoglobin indicator may be useful if a bloody tap is suspected as the cause of turbidity or a high protein reading.<sup>10</sup> It will require a greater number of cases than in this series to fully evaluate this factor.

It is interesting to note that just about a quarter (11 of the 46 patients) who had lumbar punctures done at a non-White paediatric outpatient department had CSF abnormalities. The commonest reason for lumbar puncture was convulsions. Tuberculous meningitis was slightly more frequent than purulent meningitis.

In conclusion, though not a replacement for laboratory investigations, the test is useful as a rapid screening of the CSF, the protein factor being the most useful. Ames Laboratories make a reagent strip (Uristix) which tests only for protein and glucose, and may be as useful as Hema-Combistix.

#### SUMMARY

47 cerebrospinal fluids from 46 patients, were tested with Hema-Combistix and the results compared with routine laboratory investigation. It was found that the protein investigation correlated very satisfactorily, and this is a good, clean, rapid and easy screening test for detecting an abnormal CSF. Sugar testing was less reliable, but could be used to show whether glucose was present or absent.

We wish to thank Dr. J. Ware, Medical Superintendent of Livingstone Hospital, for permission to publish; and Sister M. Readhead, representative of Ames Company, for supplying the reagent strips and for her full cooperation.

## REFERENCES

1. Hema-Combistix information leaflet, Ames International.
2. Leonards, J. R. (1957): *J. Amer. Med. Assoc.*, **163**, 260.
3. Baron, D. N. and Newman, F. (1958): *Brit. Med. J.*, **1**, 980.
4. Kirkland, J. A. (1959): *Lancet*, **2**, 1144.
5. Flood, F. B. (1959): *J. Amer. Med. Assoc.*, **171**, 1678.
6. Langfields, G. M., Holland, D. E., Lake, A. J. and Knight, E. M. (1960): *Amer. J. Clin. Path.*, **33**, 550.
7. Kunin, C. M., Southall, I. and Paquin, A. J. (1960): *New Engl. J. Med.*, **263**, 817.
8. Kirkland, J. A. and Haslock, M. R. (1961): *Lancet*, **1**, 693.
9. Blecher, J. A. (1965): *S. Afr. J. Obstet. Gynaec.*, **3**, 70.
10. Frazer, S. C. (1958): *Brit. Med. J.*, **1**, 981.
11. Caraway, W. T. (1962): *Amer. J. Clin. Path.*, **37**, 445.
12. Fetter, M. C., Rebar, J. and Metzler, I. (1959): *Amer. J. Med. Technol.*, **27**, 401.
13. Logan, J. E. and Haight, D. E. (1964): *Canad. Med. Assoc. J.*, **91**, 581.
14. Winter, A. and Ross, G. (1960): *J. Med. Soc. N.J.*, **57**, 252.
15. Kutter, D. (1964): *Helv. paediat. Acta*, **19**, 490.