THE ELECTROLYTE CONTENT OF THE SWEAT IN FIBROCYSTIC DISEASE OF THE PANCREAS

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A diagnosis of fibrocystic disease of the pancreas is usually based on the following clinical criteria: failure to grow at the normal rate despite an adequate calorie intake, the passage of frequent loose, offensive stools often with a characteristic odour, and the tendency to respiratory tract infections which prove unusually resistant to treatment. These symptoms, together with a finding that pancreatic enzyme activity is absent in samples of duodenal juice obtained by intubation, establish the diagnosis. The collection of adequate samples of duodenal juice for analysis may prove tedious both for the ward and the patient and an alternative diagnostic procedure of greater simplicity would be an advantage. The concept of fibrocystic disease has undergone some change in recent years and it is now generally agreed that it is a disease of mucus and non-mucus secretory glands. One of the most interesting developments is that the electrolyte content of sweat and saliva may be abnormal in patients with the condition. It was observed (Di Sant'Agnese, Darling, Perera and Shea, 1953) that levels of sodium above 80 m.Eq. per litre and chlorides above 60 m.Eq. per litre in the sweat were diagnostic of fibrocystic disease. Similar results for the electrolyte content of sweat in fibrocystic disease have been recently reported by Finch (1956). The present paper confirms that the sweat electrolytes are abnormally high in known cases of the disease and describes a convenient technique for the collection and analysis of specimens of sweat.

Experimental

Material. Specimens of sweat were obtained from 12 patients with fibrocystic disease, varying in age from 11 months to 6 years. All 12 were proven cases in each of which pancreatic enzymes had been shown to be absent by at least one duodenal intubation. The control series consisted of 20 ward patients, varying in age from 3 months to 6 years, with no disease or symptoms referable to the gastro-intestinal tract.

Collection of Specimens. The ward was supplied with two weighed plastic tubes with close-fitting plastic stoppers (weight about 6 g.) each containing a single circular piece (7 cm. diameter) of Whatman No. 42 filter paper and two plastic sheets (approximately 10 cm. square). The plastic tubes and sheets had been previously washed with soap and water, then distilled water and finally dried at 37° C. for 24 hours. A box of clean filter papers was also included together with a bottle of distilled water, waterproof adhesive plaster, forceps and scissors. The equipment is illustrated in Fig. 1. The plastic squares were joined by means of a single strip of waterproof plaster which was then fixed to the spine, the filter papers being placed underneath the plastic squares and the whole secured with further strips of plaster (Fig. 2). The back was previously cleaned several times with filter papers soaked in distilled water and carefully dried. All these manipulations were performed with the clean forceps, and care was taken to place the filter papers symmetrically either side of the spine and as far as possible in similar areas in the different patients. The axillae were avoided because the apocrine secretion differs in its electrolyte composition. The patient was then placed in a plastic bag tied loosely with tapes around the neck (Fig. 3) and allowed to lie in a cot or bed covered with three or four blankets. In some instances the children were restive at first but quickly became used to the conditions. Experience showed that sufficient sweat had been absorbed by the filter papers when the inside of the bag became visibly wet, usually within one to two hours. Any gross contamination of the fluid inside the bag with urine was obvious. The

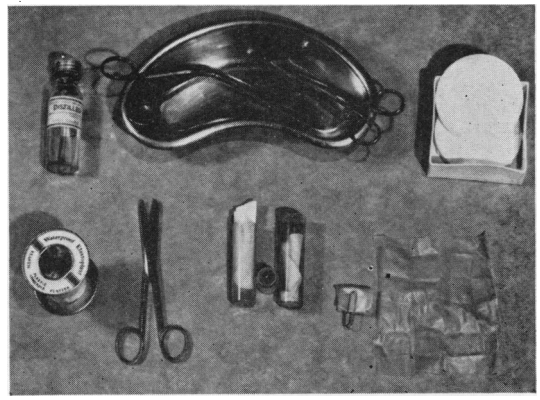

FIG. 1.—Equipment for collection of specimens of sweat.

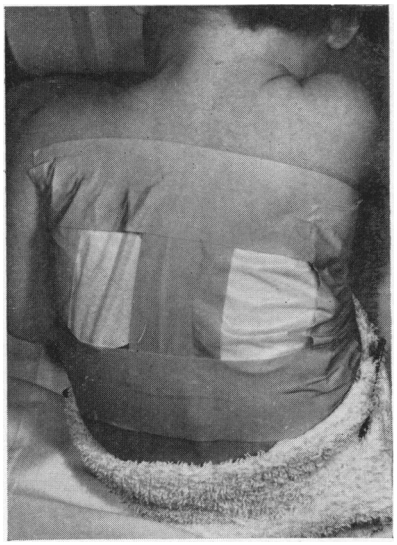

FIG. 2.—Mode of attachment of filter papers and plastic strips to child.

plaster and plastic strips were then removed and the filter papers transferred to the plastic containers with the forceps and immediately taken to the laboratory.

Analysis of Specimens. The plastic containers and filter papers were reweighed, the increase in weight being the amounts of sweat collected (usually 0·5 to 2·0 g.),

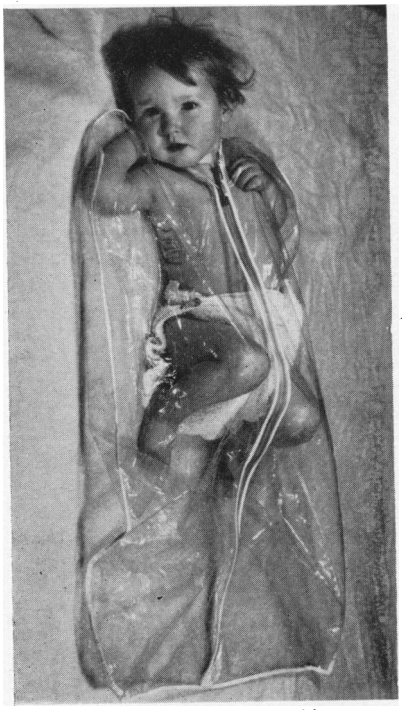

FIG. 3.—Plastic bag in position.

5 ml. of glass-distilled water were added to each container and the mixtures shaken until the filter papers had disintegrated to a pulp. After passage through a sintered glass filter to produce an optically clear filtrate, chloride was estimated by the method of Schales and Schales (1941) which involves a direct titration with standard mercuric nitrate solution using diphenylcarbazone as an indicator. A further 1 ml. of the filtrate was diluted suitably, e.g., 1 to 50, the actual dilution being based on the chloride content of the specimen, for the estimation of sodium by the flame photometer. The results were calculated as m.Eq. of chloride or sodium per litre of sweat. The use of two pieces of filter paper enabled duplicate estimations to be performed on each patient.

Results

Table 1 gives the results for 20 controls and Table 2 those for 12 patients with fibrocystic disease.

TABLE 1
ELECTROLYTE CONTENT OF SWEAT IN 20 CONTROL PATIENTS

Case No.	Age	Sex	Electrolyte Content of Sweat (m.Eq./litre)	
			Sodium	Chloride
1	3 months	M	25	24
2	3 months	M	32	31
3	4 months	F	16	14
4	4 months	M	11	12
5	7 months	M	13	18
6	8 months	F	37	38
7	11 months	M	19	17
8	11 months	F	29	25
9	1 year	F	52	40
10	14 months	F	33	27
11	18 months	F	4	9
12	2 years	M	16	17
13	2 years	M	40	40
14	2 years	F	48	25
15	3 years	M	25	20
16	4 years	F	19	9
17	5 years	M	23	16
18	5 years	F	34	28
19	5 years	F	35	36
20	6 years	F	27	20
Mean ± standard deviation ..			27±12	23±10
Range			4 – 52	9 – 40

TABLE 2
ELECTROLYTE CONTENT OF SWEAT IN 12 PATIENTS WITH FIBROCYSTIC DISEASE

Case No.	Age	Sex	Electrolyte Content of Sweat (m.Eq./litre)	
			Sodium	Chloride
1	11 months	F	142	144
2	2 years	F	106	128
3	3 years	M	72	68
4	3 years	M	143	148
5	4 years	M	128	125
6	4 years	M	119	127
7	4 years	M	138	136
8	5 years	F	126	126
9	6 years	M	157	145
10	6 years	F	135	141
11	7 years	F	95	95
12	7 years	M	138	136
Mean ± standard deviation ..			125 ± 24	127 ± 23
Range			72 – 157	68 – 148

TABLE 3
COMPARISON OF ELECTROLYTE CONTENT OF SWEAT IN CONTROLS AND PATIENTS WITH FIBROCYSTIC DISEASE

Reference	Controls			Fibrocystic Patients		
	No. of Cases	Sodium (m.Eq./l.)	Chloride (m.Eq./l.)	No. of Cases	Sodium (m.Eq./l.)	Chloride (m.Eq./l.)
Di Sant'Agnese *et al.* (1953) ..	50	59 10–120	32 4–80	43	133 80–190	106 60–160
Finch (1956)	30	27 7·7–59	18 trace–50	6	107 86–132	108 85–138
Present work	20	27 4–52	23 9–40	12	125 72–157	127 68–148

The statistical significance of the differences between the mean results for sodium and chloride of the controls and fibrocystic patients were analysed by Student's t test and values of P of $<0{\cdot}001$ were obtained in each case. Table 3 includes the results of the present work together with the figures reported by other workers.

Discussion

The results of the present work fully confirm the report of Di Sant'Agnese *et al.* (1953) that the estimation of sodium and chloride in sweat is very useful in the diagnosis of fibrocystic disease. In our series there was a highly significant statistical difference between the content of these two electrolytes in the sweat specimens from the controls and from the fibrocystic cases. It may be concluded that sodium and chloride levels above 70 m.Eq. per litre in sweat specimens, collected according to the method described in the experimental section above, together with typical clinical findings, are diagnostic of fibrocystic disease. However, adherence to the details of collection is important in that the electrolyte content of sweat in any individual varies with a number of factors such as the area of collection, nature and intensity of the stimulus to sweating, environmental temperature, dietary intake and adrenocortical activity. We have attempted to devise a reasonably standard and simple procedure which could be used in most hospital wards. The method differs from the technique of Di Sant'Agnese *et al.* (1953) mainly in the use of filter papers and plastic containers instead of pads of gauze and glass vessels. This modification enables the weight of the sweat specimen to be more accurately measured because it is a greater fraction of the total weight of the containers. The chemical analyses are simple and we consider that the method is a desirable alternative to duodenal intubation in which the difficulties of collection and analysis of the specimens are much greater. It is of interest that when the purpose of the test was being explained several parents of the fibrocystic patients commented on the salty sensation experienced when kissing their children.

Summary

A method for the collection of specimens of sweat is described and the sodium and chloride content of sweat from control subjects and fibrocystic patients have been measured.

The electrolyte content of sweat from fibrocystic patients is significantly higher than that of sweat from the control subjects.

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