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TREATMENT OF IDIOPATHIC HYPERHIDROSIS WITH IONTOPHORESIS OF TAP WATER AND POLDINE METHOSULPHATE

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SUMMARY.—Iontophoresis of tap water or of an anticholinergic compound (poldine methosulphate) was simple and useful in the treatment of idiopathic hyperhidrosis of the palms and soles. Axillary hyperhidrosis was not so easily controlled. Poldine was more effective than tap water; with increasing doses, systemic effects were produced.

Treatment was arranged easily in the Physical Medicine Department. It was suggested that, before resorting to surgery, iontophoresis is worth a trial in idiopathic hyperhidrosis.

TREATMENT of primary hyperhidrosis of the palms, soles or axillae is notoriously difficult. Failure of medical treatment is common, and there is reluctance to recommend surgery for a condition that is so frequently self-limiting. Surgery is, however, often very effective. Axillary hyperhidrosis may be well controlled by excision of sweat gland-bearing central axillary skin, although post-operative infection, scarring or hidradenitis may occur (Hurley and Shelley, 1967; Gillespie and Kane, 1970; Davis, 1971). Upper thoracic sympathetic ganglionectomy relieves hyperhidrosis of the hands, but may result in Horner's syndrome, pleural perforation, pleural effusion or phrenic nerve damage (Cloward, 1969; Greenhalgh *et al.*, 1971).

An alternative simple treatment of hyperhidrosis of the palms and soles was suggested by Levit (1968). This was iontophoresis of tap water. The attempts to introduce heavy metals into the body by iontophoresis (electrophoresis) were described in the eighteenth century (Burdick, 1966). The apparatus required for iontophoresis is a simple source of direct current of low voltage and low amperage. The skin resistance is lowest through the sweat ducts: hence the flow of current ions through the skin is greatest through the sweat ducts. A punctate skin pattern due to staining of sweat pores can be shown after iontophoresis of methylene blue (Papa, 1966).

The present study confirms the simplicity and usefulness of Levit's suggested treatment, and reports preliminary investigations on the iontophoresis of an anticholinergic compound, poldine methosulphate.

METHOD AND APPARATUS

The iontophoresis apparatus.—In the present study the apparatus used for iontophoresis was similar to that described by Levit (1968). Treatment was carried out in the Physical Medicine Department, or in the laboratory.

Electrodes.—Copper electrodes were used throughout (ideally platinum should be used instead of copper). An electrode, approximately the size of a hand or foot, was placed

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in the bottom of a shallow tray filled with tap water. The hand or foot to be treated was placed on the surface of the water so that the palms or soles were just submerged. Axillary electrodes (42 cm^2), shaped to fit the axilla, were well covered with gauze padding soaked in tap water.

Where only 1 side was treated an " indifferent " electrode, padded and soaked in tap water, was wrapped around the upper arm. If both sides were to be treated simultaneously, the circuit was completed by placing the second electrode either in the axilla or in tap water under the palm or sole.

Current.—Most patients could tolerate 15–20 mA for treatment of the hands or feet. For the axillae 10–15 mA were used (0·3 mA/cm^2 × area of axillary electrode). Painful sensation is produced at the anode by the liberation of acids (HCl when saline is used) and at the cathode by hydroxides (NaOH if saline is used).

Treatment was given for 15 min once or twice per week for 6 to 8 weeks.

TABLE I

	Years	
	Mean	Range
Age of onset	14	1–30
Age of attendance at outpatients	23	10–48
Duration of hyperhidrosis	7	0·5–20

TABLE II

Sites affected		Number of cases
	Feet	13
	Hands	12
	Axillae	10
	Trunk	2
Emotion stimulus	Feet	6
	Hands	9
	Axillae	6
	Trunk	2
Heat stimulus	Feet	5
	Hands	4
	Axillae	6
Exercise stimulus	Feet	3
	Hands	3
	Axillae	4

Anticholinergic compound.—The anticholinergic compound chosen for initial investigation was poldine methosulphate, as its possible side effects are well known. It has been used systemically since 1957 for treatment of peptic ulcers, and has been used topically to produce anhidrosis (Grice and Bettley, 1966).

For iontophoresis, poldine methosulphate, 0·05–0·075% in distilled water, was used at the anode.

The decrease in concentration following treatment was used as a measure of migration of poldine through skin. Poldine methosulphate was measured quantitatively by spectrophotometry (Langley *et al.*, 1963).

Method for measuring sweating.—Sweating was measured quantitatively by an electrical hygrometer (Bullard, 1962; Baker and Kligman, 1967). The presence of sweating was determined by starch-iodine (Kuno, 1956) by o-phthaldiadehyde (Juhlin and Shelley, 1967) and by measuring the galvanic skin resistance, using a sudorometer (d.c. resistance meter) similar to that described previously (Bettley and Grice, 1965).

Clinical features.—Twenty-two patients with idiopathic hyperhidrosis, 10 males and 12 females, were reviewed. The clinical features are shown in Table I, II. Three

patients had a family history of idiopathic hyperhidrosis. The average age of onset was 13 years, and the mean age of attendance at outpatients was 23 years. The feet, hands and axillae were the sites most frequently involved (Table II). Emotional stimuli most commonly precipitated the attacks of hand sweating. As an example, a single case is reported in detail.

Case 1. A medical student aged 25 had severe idiopathic hyperhidrosis of the palms and soles since childhood. Sweating was not provoked by heat of exercise, but was much worse when he was studying or embarrassed. His father had similarly severe hyperhidrosis of the palms and soles, which started in childhood and cleared at the age of 20.

Conventional medical treatment improved 8 patients but had little effect on the remaining 13. Medical treatment included the usual oral anticholinergic compounds, sedatives, topical aluminium compounds, formaldehyde applications and topical poldine under polythene occulsion.

Thirteen patients were treated by iontophoresis. In order to have a quantitative comparison, 1 palm, sole or axilla was treated by one method and the opposite side was either left untreated or treated by another method. Tap water was used on the following sites: soles (9 cases), palms (6 cases) and axillae (4 cases). Poldine was used for soles (10 cases), palms (8 cases) and axillae (5 cases).

Where sweating was noticed to differ on the 2 sides, the more severely affected side was treated with the more effective method. A natural asymmetry of sweat delivery has been reported in 20% of people (Herrmann *et al.*, 1952).

RESULTS

Iontophoresis of either tap water or poldine methosuphate diminished sweating (Table III).

Tap Water

Tap water was less effective than poldine. Some patients with hyperhidrosis of the palms or soles were well controlled by tap water. One patient with extremely severe palmar hyperhidrosis was successfully treated by tap water. His treated hand remained dry, however, for only 2–3 weeks, and he needed further treatment at 2-monthly intervals. He was the medical student described previously.

Two children cleared completely for 2–3 months, although treatment had been given to only one side. Probably iontophoresis precipitated a natural remission. Relapses occurred in others 2–4 weeks after iontophoresis of tap water. Skin trauma resulting from iontophoresis was avoided if correct current dosage was employed, and any breaks in the skin surface were covered with grease before starting treatment.

Poldine

The hypohidrotic effect of poldine was more marked than that of tap water. The effect was very striking in 2 patients. They both failed to respond to tap water. Previous to treatment their hands constantly dripped sweat on the floor. After treatment their hands and feet were dry. One patient, 4 months later, had only minimal visible emotional sweating of the hands, feet and axillae. The other patient, however, relapsed after 3 weeks.

Two patients had a complete remission for 2–3 months after unilateral poldine had been given.

TABLE III.—*Effect of Iontophoresis on Sweating*

Site	Number of treatments	Sweat loss compared on 2 sides of the body (mg/cm²/h)	
		Side treated with poldine	Untreated side
Palm	13	4·2	28·1
Palm	10	2·8	27·7
Palm	7	2·3	24·3
Palm	7	3·3	14·7
Palm	3	9·1	27·0
Palm	1	2·8	9·6
Foot	8	5·9	26·6
Axilla	4	1·5	5·6
Axilla	1	44·2	50·0
		Treated with poldine	Treated with tap water
Palm	3	1·1	6·6
Palm	1	3·6	6·0
Foot	2	2·1	4·2
Foot	1	2·4	4·8
		Treated with tap water	Untreated
Palm	17 (reading obtained 2 weeks after last treatment)	1·9	11·3
Palm	13 (reading obtained 4 weeks after last treatment)	7·8	11·2
Palm	11	2·6	8·8
Palm	8	3·1	5·8
Palm	8	5·0	5·6
Palm	5	7·7	16·8
Foot	6	13·5	15·8
Foot	5	2·9	4·6
Axilla	5	14·1	16·7
Axilla	3	16·0	24·2

TABLE IV.—*Decrease in Concentration of Poldine Methosulphate (Due to Migration Through Skin) Following Iontophoresis for* 15 *min*, 10–20 *mA*

Site of iontophoresis	Poldine methosulphate: Pre-treatment (mg/100 ml distilled water)	Poldine methosulphate: Skin absorption = post-treatment decrease in concentration (mg/100 ml)
Hand	75	4·2
Hand	75	4·1
Hand	75	2·7
Hand	75	8·8
Hand	75	1·7
Hand	75	1·7
Hand	28	3·4
Hand	13·3	2·7
Hand	96	2·7
Hand	10·6 (mg/100 ml tap water)	1·8
Hand	10·35	10·0

Poldine iontophoresis was most effective on the palms and least effective in the axillae. Four cases of hand and foot hyperhidrosis had remissions which lasted only 2–6 weeks. Three axillary hyperhidrotics were not adequately controlled.

Iontophoresis with poldine 50/100 ml in distilled water on 1 hyperhidrotic area per treatment (one palm, sole or axilla) caused no side effects and could be used with impunity. Larger doses or treatment of more than 1 area at a time was liable to cause side effects. The rate of disappearance of poldine resulting from iontophoresis was 1·7 to 18 mg/treatment/palm. The treatment dosages are shown in Table IV. To be effective the concentration of poldine had to be a great deal higher when tap water was used instead of distilled water. Concentration of up to 0·5% poldine could be tolerated with tap water, whereas side effects could be produced by <0·1% solution in distilled water.

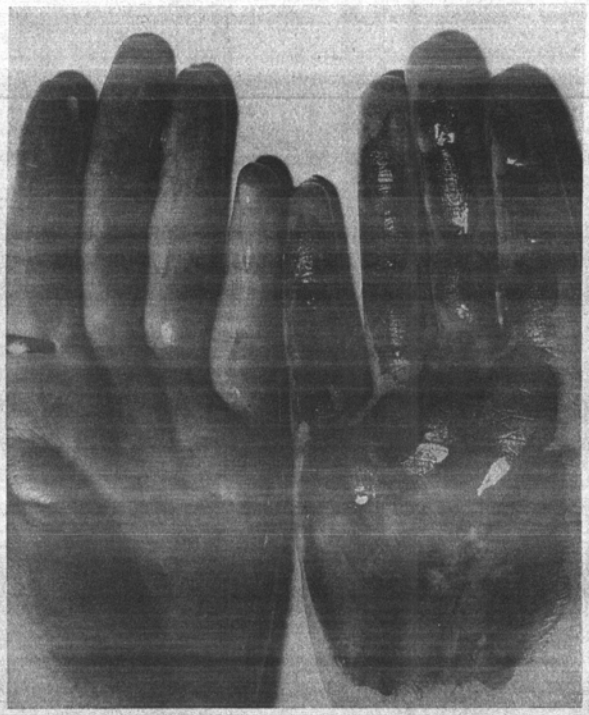

FIG. 1.—Three days after 7 treatments with iontophoresis of poldine to left hand; right hand untreated. Hyperhidrosis of right hand seen with starch-iodine; minimal sweating left hand.

The commonest side effect from percutaneous absorption of overdose of poldine was a dry mouth. Hypohidrosis of the untreated limb occurred on a few occasions, and mydriasis on 2 occasions. One patient complained of a gritty feeling of the eyes. The side effects occurred 15–30 min after treatment and lasted for 1–2 h.

CONCLUSION AND DISCUSSION

These preliminary findings confirm the usefulness of iontophoresis in the treatment of hyperhidrosis of the palms and soles. Most physical medicine departments have the apparatus and staff trained in its use.

Tap water produces no side effects and is easy to administer, provided the usual precautions are taken. Tap water may not be sufficiently effective, however, for treatment of hand and foot hyperhidrosis. Axillary sweating was never adequately controlled.

Poldine methosulphate was more effective, but was more difficult to administer. Hand and foot hyperhidrosis could always be controlled, but, as with tap water administration, the effect was often of short duration, and further courses of treatment were needed. In some cases long-lasting improvement (up to 3–4 months) were obtained; the treatment in these cases had possibly precipitated a natural remission.

Systemic side effects were produced by iontophoresis of poldine in high doses. When taken by mouth, there is a wide range of tolerance to poldine, side effects being produced by just under 10–100 mg (Lennard-Jones, 1961). The effect of topical poldine under polythene occlusion lasts for about 1 week (Grice and Bettley, 1966). Longer acting anticholinergics are being investigated, as are the effects of length of administration, current value and concentration of solution. Axillary hyperhidrosis was frequently not adequately controlled by poldine.

Solutions of poldine were not re-used after treatment, as the resulting concentration after treatment was not sufficiently predictable. Wahlberg (1970) showed that the maximum absorption of chromate (^{51}Cr) and sodium (^{22}Na) ions after iontophoresis was 43 and 8 times greater, respectively, than after local application. He used the rate of disappearance of the isotopes from the skin surface after iontophoresis to measure the rate of penetration of the ions through skin.

By measuring the uptake by the tissues of ^{32}P, O'Malley and Oester (1955) showed that increasing the concentration, current and duration of iontophoresis increases skin absorption. These findings were similar when using $Ra^{131}I$ (Zankel, 1963) and ^{51}Cr (Wahlberg, 1970). ^{22}Na clearance, however, was little affected by duration or current. The effective concentration of poldine in distilled water was lower than that in tap water. This was due to the presence in the tap water solution of ions other than poldine methosulphate which would be attracted to the sweat ducts.

The cause of sweat inhibition following iontophoresis of tap water is said to be upper epidermal blockage of sweat glands; removal of the stratum corneum by stripping with Scotch tape relieves the obstruction. Larger current density affects deeper levels of the sweat apparatus (Gordon and Maibach, 1969.)

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