THE COMPARATIVE EFFICIENCY OF VARIOUS TECHNIQUES FOR THE DIAGNOSIS OF THREADWORM INFECTION

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When infection by threadworms is suspected it is essential before starting treatment to confirm the diagnosis by recovering ova of the parasite from the perianal skin. This is the more important since, as Lane (1944) remarks, 'no drug is yet known that is deadly to the worm yet less risky to man than is the infection', and the clinical picture is variable and unreliable as a basis for diagnosis.

Much work has been published during the last two decades on the diagnosis of threadworm infection, and the literature contains many accounts of methods for the recovery of the ova from the patient but few of the comparative efficiency of these techniques. Indeed, heretofore, no exact methods have been devised for the accurate comparison of one technique with another, although within recent years various workers have compared the value of perianal swabbing and scraping with that of faecal examinations or have assessed the relative merits of such newer devices as the NIH (National Institute of Health of the U.S. Public Health Institute) swab, the adhesive cellophane swab and the glass pestle by repetitive examination of the same group of infested individuals. Multiplicity of techniques has given rise to confusion. We therefore decided to investigate, by controlled experiments, the relative efficiency of some recent and improved diagnostic methods, and by clinical practice to assess their relative convenience and speed. The experimental work has been carried out in the Wellcome Laboratories of Tropical Medicine and the clinical work in the wards of The Hospital for Sick Children, Great Ormond Street, London.

Two new types of anal swab were developed which were exhibited before the Royal Society of Tropical Medicine (Watson and Mac Keith, 1947a) and the Royal Society of Medicine (Watson and Mac Keith, 1947b), and are described below.

Historical Survey

Although the extra-corporeal oviposition of *Enterobius vermicularis* was known before his day, Davaine (1860) was the first to suggest searching the perianal region for the worms and their ova rather than examining the faeces, and Vix (1860) was the first to recommend the use of a probe, curette, spatula or ivory scalpel handle for this purpose. Heller (1876) proposed the examination of any piece of paper that might have been used after defaecation, a method which was later improved and developed into the T.P. (toilet paper) swab (Watson and Mac Keith, 1947).

Various types of cotton, chamois and rayon swabs, and glass, metal, wooden and celluloid scrapers were subsequently introduced but they showed little advance over the original method of Vix.

The first major improvement was made in 1933 when Hellsten suggested wiping the perianal region with a vaselined cloth and shaking up the material obtained with a mixture of water and ether which could then be centrifuged and the sediment examined for ova. Although efficient in the recovery of threadworm eggs this method was too cumbersome and time-consuming to be generally adopted. A similar technique was introduced by Kevorkova (1946) who used a moist cotton-wool swab to wipe the anal region and then placed it in a test tube partly filled with water which was vigorously shaken before removal of the swab and centrifugation. Still more recently Markey (1950) proposed an improvement on Kevorkova's method by coating the cotton-wool swab with a mixture of vaseline and wax and substituting xylol for water in the tube.

In 1937 Hall evaluated the comparative efficiency of many of the types of swabs and scrapers previously suggested and showed that they were all

unreliable. He introduced the NIH cellophane swab which rapidly gained universal approval and adoption. Jones (1938) clarified details of its use. Reardon (1938) described the artefacts in cellophane which might simulate threadworm eggs. Folan (1939) dealt with the preparation and cleaning of the swab. Boycott (1949) introduced slight modifications in the design and method of use.

Another step forward was taken in 1941 when the use of adhesive cellophane tape instead of ordinary cellophane was independently suggested by Graham and in 1942 by Jacobs. This method has been even more widely adopted than the NIH swab and modifications of it have been suggested by Von Hofe (1944), Brooke, Donaldson and Mitchell (1949) and Beaver (1949). Ebert (1949) proposed the attachment of the adhesive cellophane strip to the anal cleft covering the anus overnight so that the worms would actually oviposit on it. Hitchcock (1949) studied the occurrence of egg-like artefacts in adhesive cellophane tape and concluded that they were rare.

In 1943 Schüffner and Swellengrebel published the first description of a device entirely new in principle and design, arising out of the observation that the ova of *E. vermicularis* are always laid in clumps which might be missed by a swab or scraper. This instrument, consisting of a small glass pestle with a rough-ground end which was wetted before application, was designed to break up these clumps into a suspension so ensuring that none should be missed. The authors claimed that in clinical trials it was superior to the NIH swab.

In 1945 Petersen and Fahy proposed to simplify the process of recovering ova from the patient by pressing an ordinary microscope slide on to the perianal skin and examining it directly under the microscope.

Finally, in 1946 Watson and Mac Keith introduced the use of a moistened camel-hair brush for the collection of eggs from the perianal region (Watson and Mac Keith, 1947).

Since that date modifications of existing methods but no substantially new techniques have been introduced. One of the most useful innovations was the differentiation of living from dead ova by staining with fluorochrome acridine orange (Beckers, 1949).

Sawitz (1940), Sawitz, Odom and Lincicome (1939) and McMullen (1949) have dealt with the question of the number of negative swabs necessary to prove that a patient is not infested with threadworms. Their findings are in no way invalidated by ours.

Comparison of the relative efficiency of diagnostic

methods has been confined to empirical conclusions or to the consecutive use of two devices on the same group of patients. In this way Sawitz *et al.* (1939), Sawitz (1940) and Miller and Einhorn (1944) have compared the NIH swab with faecal concentration methods; Kuitunen-Ekbaum (1942), Mazzotti and Osorio (1942 and 1945), Meneses Rubiáñez and Avendaño Escalante (1949) and Jeffrey (1950) have compared the NIH swab with the glass pestle and the adhesive cellophane swab. The general consensus of opinion of these authors was that the NIH swab was greatly superior to faecal concentration methods; that the glass pestle was superior to the NIH swab; and that the adhesive cellophane swab was superior to the glass pestle.

Material and Methods

The purpose of the experiments was to determine the percentage of ova which would be picked up from the human skin and revealed by microscopic examination in the case of each of the different devices under investigation, and so to obtain figures which could be used in comparing their relative efficiency.

Since infection of experimental animals with *Enterobius vermicularis* is not possible, and since human infection could not be controlled, the ova of the rabbit threadworm, *Passalurus ambiguus*, were employed throughout the experiments. This made it easier to obtain uniform conditions for repeated series of observations than would have been the case with human threadworms.

The ova of *P. ambiguus*, although slightly larger than those of the human threadworm, are similar in shape and have the same inner lipoidal, middle chitinous and outer albuminous layers of the shell, and it was therefore concluded that any results obtained with them would be valid for the eggs of *E. vermicularis*.

Between the hard, dry pellets of faeces in the rectum of freshly killed rabbits were often found gravid female worms on the way to the exterior to discharge their ova. At first only these specimens were used in the tests, but unfortunately when exposed to air by the opening of the rectum many of them discharged their eggs before they could be transferred to the experimental surface and were thus useless. Later, however, it was found that if, in a heavily infected rabbit, the caecal contents were removed into a shallow basin and placed in an incubator at blood-heat, most of the worms came to the surface of the mass within a few minutes, and large females could then be picked out and allowed to oviposit on the selected area of skin. This was more satisfactory than the use of specimens from the rectum since a greater length of time elapsed between picking up the worms in the forceps and the act of oviposition.

The efficiency of the diagnostic techniques was investigated using not only dry ova but also those which had been wetted, in case the adhesiveness of the outer layer of the eggshell was reduced by wetting.

In one group of experiments gravid females were allowed to oviposit, one at a time, on the palm of the

hand. Any worm which did not oviposit voluntarily was discarded, since in immature specimens the albuminaceous outer layer of the eggshell might not have the same degree of stickiness. The diagnostic device was then applied to the area of egg-deposition, normally a circle of about one centimetre diameter, after an interval of two or three minutes to allow drying to take place.

In a second group of experiments a large number of gravid female worms were transferred to a small volume (about 5 ml.) of physiological saline and cut into very fine pieces so as to liberate the ova from the body. A suspension of eggs was thus obtained from which, after thorough shaking to ensure even distribution of the ova through the liquid, several drops were removed with a fine pipette and placed separately on microscope slides. By using the same pipette held at the same angle on each occasion, drops of uniform size were obtained. At the same time, using precisely the same technique, a series of drops was placed on marked areas along the skin of the underside of the forearm and allowed to dry. The diagnostic devices were then applied to the areas covered by the dried drops. Counts were then made of the number of ova in the control drops on the slides and the percentage of ova recovered by each device on each application could then be calculated.

Diagnostic Devices

The patients were children between the ages of 9 months and 2 years, together with a small number of adults. The purpose of the clinical investigations was to compare the relative facility with which each device could be employed in practice, the average time occupied in its use, subsequent manipulation and microscopic examination, and the degree of discomfort to the patient.

The devices employed were the NIH swab, the TP swab, the glass pestle, the adhesive cellophane or Graham swab, the direct slide and the brush. We have already described them in an earlier paper (Watson and Mac Keith, 1947).

A number of different clearing agents were tested subsequently in connexion with the TP swab, and some account of this work may not be out of place. The best results were obtained by the use of oil of wintergreen. A dilute solution of light green in clove oil stained the background green while the unstained eggs appeared yellow. Clove oil alone also produced excellent contrast, the eggs appearing yellow against a white background. Beechwood creosote was almost equally good when viewed with minimal light. Lactophenol gave a good result only with strong illumination. Glycerin at first trapped numerous air-bubbles in the paper but after standing overnight gave better contrast than any other reagent. Monnig's medium (gum arabic 60 parts, glycerin 40 parts, chloral hydrate 100 parts, thymol 1 part) was satisfactory when tinted with eosin, the ova at first remaining unstained and showing up well against the coloured paper and later becoming more deeply stained than the paper. Cedar-wood oil, xylol, benzol, liquid paraffin, chloroform and acetone were all unsatisfactory as both eggs and paper became too transparent and there was insufficient contrast. Caustic potash and

soda solutions were also useless as they failed to render the paper transparent. The preparations lasted for several days without the necessity of sealing the edges of the coverslip but showed a decreasing degree of contrast between paper and eggs as the latter gradually cleared. Numerous different varieties of toilet paper were investigated but the only unsuitable one was the crinkled type, which would not lie flat on the slide. Tissue paper was found to clear exceptionally well and would have been superior to toilet paper but for the fact that it tore very easily and required more careful handling.

Experimental Results

Experiments with Dry Eggs. The results of the first series of experiments in which ovipositing female threadworms were used and the eggs allowed to dry before carrying out the test are set out in Table 1 which gives the actual number of ova recovered in each operation.

TABLE 1
NUMBERS OF OVA RECOVERED BY EACH DEVICE

Test	NIH Swab	TP Swab	Adhesive Cellophane Swab	Glass Pestle	Direct Slide	Camel Hair Brush
1	8	5	130	19	136	71
2	100	221	82	12	3	623
3	255	15	442	13	166	37
4	56	1	210	76	3	68
5	150	5	125	26	42	121
6	118	559	139	100	41	236
7	110	163	521	63	62	140
8	180	402	34	196	124	65
9	189	81	288	96	128	174
10	190	594	129	248	184	174
11	168	749	208	57	150	518
12	26	5	108	113	74	131
13	248	22	340	16	148	138
14	23	68	215	21	227	290
15	176	262	37	56	84	405
16	249	55	354	106	51	238
17	148	349	144	223	168	182
18	412	35	219	79	52	243
19	224	59	51	7	108	209
20	60	192	108	51	43	428
21	125	171	391	40	208	497
22	235	6	33	2	91	564
23	149	54	222	3	126	506
24	18	162	259	7	75	166
25	134	174	290	183	50	464
Mean	134	176	203	73	103	266

Since the NIH and TP swabs and the brushes remained in their tubes for several days before being examined, some of the ova might have become detached and be lying loose at the bottom of the tubes. Each tube was therefore washed out with water, the washing centrifuged, and the sediment examined. In only one instance (an NIH swab tube) were any ova discovered and in this case only a single egg was found. Evidently then the adhesiveness of the egg is sufficient to ensure its adherence to the collecting surface for several days even when, as in the case of the NIH and TP swabs

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and the brush, that surface is not in itself sticky. Thus delay in examination of the swabs does not appreciably lessen the likelihood of finding ova if any were originally present. The other three methods depended upon the adherence of the eggs to the surface of slides which were kept flat and did not therefore suffer from the same disadvantage.

Many of the eggs picked up by the brush are not delivered to the cavity slide for examination at the first dipping. Each brush was dipped consecutively into caustic soda solution three times. The number recovered at the second and subsequent dippings is always less than that recovered the first time (see Table 2), and no doubt depends on

TABLE 2
NUMBER OF OVA RELEASED FROM THE BRUSH

Test	First Dipping	Second Dipping	Third Dipping
1	71	—	—
2	623	—	—
3	37	—	—
4	68	42	26
5	121	106	67
6	236	127	50
7	140	77	12
8	65	60	32
9	174	154	73
10	518	470	—
11	174	92	61
12	131	30	31
13	138	57	32
14	290	90	17
15	405	116	19
16	238	36	16
17	182	171	95
18	243	115	52
19	209	10	6
20	428	125	86
21	497	67	23
22	564	126	49
23	506	61	13
24	166	84	53
25	464	207	168

the lapse of time between oviposition and application of the brush, the temperature of the caustic soda solution and the degree of mechanical agitation employed. For the purposes of this study only figures obtained from the first dipping of each brush are taken into account.

In order that a valid comparison between the figures established for the six different methods might be made it was necessary to relate them to the number of ova produced by the adult female worm. *Passalurus ambiguus*, although similar in dimensions to *Enterobius vermicularis*, has larger ova and a smaller number are therefore present in the gravid female. Search of the literature revealed no estimate of this number and it was therefore assessed experimentally. The technique of Reardon (1938) was adopted, each worm being cut into four pieces in a drop of glycerin and water on a slide and the eggs extracted by teasing with mounted

needles. Adult females were obtained from the rectum of the lower part of the colon of infected rabbits and killed by immersion in hot alcohol-glycerin. Counts were made on 25 specimens, the results of which are given in Table 3.

TABLE 3
NUMBER OF OVA IN GRAVID FEMALE
SPECIMENS OF *PASSALURUS AMBIGUUS*

Specimen	Ova	Specimen	Ova
1	997	14	786
2	578	15	696
3	760	16	495
4	803	17	501
5	686	18	210
6	652	19	477
7	818	20	633
8	636	21	1,044
9	741	22	720
10	669	23	364
11	510	24	858
12	856	25	734
13	* 1,019		

Arithmetic mean, 690; standard deviation, 194.02; coefficient of variation, 26.7%. Calculation of *t* shows that out of 1,000 females one might expect to find four with over 1,200 ova, six with under 200 ova, one with under 100 ova.

However, from the point of view of relating the number of eggs picked up from a single ovipositing female by the various diagnostic devices to the number of eggs which might be expected to be found in such a specimen, it is important that the efficiency of each method should not be overestimated. The arithmetic mean, or any other measure of central tendency, may give such an overestimate in any particular instance. It was therefore decided to use, for purposes of comparison a figure of 1,000 as being the maximum number of ova in a gravid female (to the nearest round number) and to express the pick-up figures for each type of diagnostic device as percentages of this maximum possible egg-number. The final assessment figures are presented in Table 4.

In judging the reliability of six diagnostic devices three different indices derived from the raw data (Table 1) were employed, namely: (1) the arithmetic

TABLE 4
ANALYSIS OF RECOVERY OF DRY OVA FROM A SINGLE GRAVID FEMALE
PASSALURUS AMBIGUUS

Device	Arithmetic Mean	Standard Deviation	Coefficient of Variation (%)	Recovery of Less than 10 Ova (%)
NIH swab ..	13.4	7.41	55	4
TP swab ..	17.6	21.95	125	25
Adhesive cellophane swab ..	20.3	12.94	64	0
Glass pestle ..	7.3	7.02	96	20
Direct slide ..	10.3	6.04	59	8
Brush ..	26.6	17.39	65	0

TABLE 5

NUMBERS OF OVA RECOVERED BY EACH DEVICE FROM DRIED DROPS OF A SALINE SUSPENSION CONTAINING 355 OVA (MEAN) PER DROP

Test	NIH Swab	TP Swab	Adhesive Cellophane Swab	Glass Pestle	Direct Slide	Brush
1	5 (1.4%)	1 (0.3%)	154 (43.3%)	74 (20.8%)	5 (1.4%)	98 (27.6%)
2	1 (0.3%)	8 (2.3%)	277 (78.0%)	76 (21.4%)	8 (2.3%)	9 (2.5%)
3	6 (1.7%)	1 (0.3%)	201 (56.6%)	93 (26.2%)	12 (3.4%)	25 (7.0%)
4	19 (5.3%)	9 (2.5%)	237 (66.8%)	88 (25.5%)	40 (11.2%)	207 (58.4%)
5	6 (1.7%)	12 (3.4%)	103 (29.1%)	85 (24.0%)	0	41 (11.5%)
6	2 (0.6%)	4 (1.1%)	175 (49.0%)	49 (13.8%)	13 (3.7%)	27 (7.6%)
7	7 (2.0%)	3 (0.8%)	85 (24.0%)	102 (28.8%)	31 (8.8%)	39 (11.0%)
8	36 (10.3%)	2 (0.6%)	131 (37.2%)	86 (24.3%)	20 (5.6%)	34 (9.6%)
9	19 (5.3%)	1 (0.3%)	148 (41.7%)	73 (20.5%)	25 (7.0%)	13 (3.7%)
10	5 (1.4%)	5 (1.4%)	200 (56.3%)	72 (20.2%)	55 (15.6%)	37 (10.5%)

mean, (2) the coefficient of variation, (3) the percentage of tests in which less than 10 ova were recovered. The final assessment was based on the combined result. The arithmetic mean may be considered the least important of these values since a high mean gives no indication of the likelihood of positive cases being missed owing to an occasional low recovery value. However, when the coefficient of variation rises, the likelihood of failure to recover any eggs when few are present also rises but it is never high in any of these methods. Clumping of ova makes it impossible to estimate statistically the likelihood of this happening. From this standpoint it is clear that there is little to choose between the adhesive cellophane swab, the NIH swab, the direct slide and the brush, all of which showed a moderately low coefficient of variation and rarely or never failed to pick up at least 10 ova. The brush and the adhesive cellophane swab displayed a slight superiority over the other two methods by reason of a higher arithmetic mean. The TP swab and the pestle both showed unreliability by their high coefficient of variation and the frequency with which they failed to recover at least 10 ova, despite the fact that the former had a high mean value.

It should be noted that the variability in picking up eggs for each method is due in part to the variability in mean female egg content as shown in Table 3. The computed coefficients of variability for each method, while artificially high, should remain valid for comparative purposes.

All conclusions were complicated by the well-known fact that the eggs tended to clump together. Statistical analysis confirmed that each egg did not have an equal and independent chance of being picked up in these tests. Comparable conditions would obtain, however, in clinical practice. The high coefficient of variation shown by the pestle indicated that perhaps it does not break up the egg-clumps as effectively as Schüffner and Swellengrebel (1943) believed.

Experiments with Wetted Eggs. The results of the second series of experiments in which a standard suspension of ova in physiological saline was used are presented in Table 5.

Analysis of this table shows that the differences in recovery values for a single method are too large

TABLE 6

ANALYSIS OF RECOVERY OF WETTED OVA FROM A STANDARD DROP OF SUSPENSION AFTER DRYING

Device	Arithmetic Mean	Standard Deviation	Coefficient of Variation (%)	Recovery of Less than 10 Ova (%)
NIH swab ..	10.6	10.3	98	70
TP swab ..	4.6	3.7	80	90
Adhesive cellophane swab ..	171.1	56.4	33	0
Glass pestle ..	79.8	13.8	17	0
Direct slide ..	20.9	16.3	77	30
Brush ..	53.0	56.3	106	10

to be accounted for by chance. It must therefore be concluded that here also every ovum does not have an equal and independent chance of recovery; in other words, some reclumping must take place either in the suspension or when it dries on the skin.

In arriving at a final assessment the same three indices were used as in the previous series of experiments. It was concluded that although the mean recovery figure with the adhesive cellophane swab was higher, the pestle was the more consistently reliable in view of its lower coefficient of variation. The pestle, in other words, is more likely to pick up some eggs every time. Neither device ever failed to recover 10 ova. Of the remaining devices, the TP swab and the NIH swab both had a low mean recovery figure and a high coefficient of variation and frequently failed to recover 10 ova, indicating a substantial degree of unreliability, while the brush and the direct slide, although showing an almost equally high coefficient of variation, had a somewhat high recovery rate and less frequently failed to recover 10 ova. In only

one instance (a direct slide test) did any of the devices fail to pick up at least one egg.

The tubes in which the NIH and TP swabs were stored were checked as before for detached eggs by washing them out and centrifuging the washings. No ova were recovered from any of them.

The much higher figures obtained with the adhesive cellophane swab, which, having itself a sticky surface, does not depend on the adhesiveness of the outer coat of the egg for its efficiency, leads to the conclusion that wetting the eggs reduces the adhesive properties of the shell. This was not unexpected since the outer layer of the egg-shell is albuminaceous and would therefore be removed by solution on wetting the egg with water. The low degree of efficiency shown by the NIH swab, the TP swab, the direct slide and the brush is thus explained, since the adherence of the eggs to these devices depends primarily upon the intrinsic stickiness of the outer shell.

Conclusion. The experiments described show that there is little to choose from the point of view of reliability in the recovery of ova between the adhesive cellophane swab, the NIH swab, the direct slide and the brush provided that the eggs have not been wetted. When wetting has taken place, however, the adhesive cellophane swab and the glass pestle are the most reliable devices.

Since it is often the case that the perianal region is wetted before examination either by washing, by perspiration or, in the case of young children, with urine, it must be concluded that the adhesive cellophane swab is the method of choice, since it alone appears reasonably reliable in the recovery both of dry eggs and of those which have been wetted. Schüffner and Swellengrebel (1943) estimate that 99% of ova present are removed from the perianal region by even a brief wash with water. This fact makes the use of the most reliable method for the recovery of the remainder even more important.

Clinical Considerations

The experiments described in the preceding section give an estimate of the reliability of the six different diagnostic methods tested. Reliability, however, is not the only criterion for judging a method of detecting threadworm infestation. If it is to be of practical value it must be acceptable to the person who is to use it whether he is research worker, general practitioner, clinical pathologist or parent. It must be simple and quick in use. In view of the repeated applications necessary to establish freedom from infestation absence of unpleasantness to the patient is important.

According to Hall (1937) a satisfactory swab for the diagnosis of oxyuriasis should have the following characteristics: (1) It should pick up threadworm eggs dependably. (2) It should deliver them to a microscope slide dependably with the minimum of manipulation. (3) It should be easy to transport with safety from infection and without loss of eggs. (4) It should cause the patient the minimum of discomfort.

The additional qualities which, in our experience, make for practical usefulness are: (5) Simplicity, which makes for ease of handling and speed in use and is especially necessary when a parent or other member of a household is requested to carry out diagnostic tests on a suspected case. (6) Availability of materials, which makes it simpler for a practitioner who meets relatively few cases to check a clinical diagnosis.

The only one of the six methods investigated which fulfils all of these requirements is the adhesive cellophane swab. It is, however, less suitable when the patient is an adult male with abundant perianal hair.

The NIH swab has the disadvantages that it needs time for preparation, is bulky for transport, is not easy to examine, since it frequently flattens unevenly and sometimes contains egg-like artefacts, and is disagreeable to the patient since the sharp corners and prickly edges of the folded cellophane often hurt the tender perianal skin of children, especially when pruritus and scratching have led to soreness.

The glass pestle has the disadvantages of needing special construction in the first instance and of requiring cleaning by scrubbing with soap and water between successive applications. Although slightly more complicated than the other methods it has, in our experience, been easily learned and practised by patients.

The direct slide has the disadvantage of requiring a great deal of time for examination, and, since ova tend to be most numerous at the edge of the slide, they can be easily overlooked if few. Patients experience considerable discomfort from the pressure of the sharp edge of the slide on the soft perianal skin, and for this reason we found this method almost impracticable in use.

The brush is bulky in transport and the process of cleaning for further use is lengthy and tedious, involving scrubbing with soap and hot water. On the other hand the brush caused least discomfort to the patient and was the easiest to examine since the ova tend to congregate in the centre of the cavity slide so eliminating the necessity for searching.

The TP swab, while requiring time for preparation,

if made up like the NIH swab and being bulky for transport, has one unique advantage which makes it the method of choice when ointment has been applied to the perianal skin to allay pruritus. In this circumstance, which renders the other methods nugatory, the paper will not clear since it will be smeared with an opaque film of ointment, but any ova which may be embedded in it can be readily detected by the use of dark-ground illumination.

In Table 7 are given the times occupied in the process of examination of the various devices for

the NIH swab, the TP swab, the adhesive cellophane swab, the direct slide, the glass pestle and the brush, the adhesive cellophane swab alone is reliable whether the eggs have been wetted or not and is the only one which fulfils all the requirements of a clinically satisfactory device. It should be replaced by one of the other devices when the patient is an adult male with abundant perianal hair.

The TP swab is the method of choice when ointment has been applied to the perianal skin since any ova embedded therein are revealed by examination with dark-ground illumination.

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TABLE 7
TIME OCCUPIED IN EXAMINATION OF EACH DEVICE
FOR OVA

Device	Time (minutes)
NIH swab	9
TP swab	7½
Adhesive cellophane swab	5½
Glass pestle	3½
Direct slide	6
Brush	2½

ova. These are average figures, obtained by careful timing of several different workers over many thousands of operations. Naturally they make no allowance for inexperience. The time taken in examination is dependent in part on the presence or absence of eggs; negative preparations naturally occupy more time than positives which may often be dismissed in a few seconds. The figures given in Table 7 are for negative preparations only and therefore represent maximum times. Schüffner and Swellengrebel (1943) found that the average time taken to examine a negative NIH swab was 11 minutes whereas a negative pestle slide could be examined in two and a half minutes as against nine minutes and three and a half minutes respectively in our tests.

Summary

The literature relating to the diagnosis of threadworm infestation is reviewed.

An account is given of investigations made to assess the relative efficiency of six different methods for the diagnosis of threadworm infestation. Clinical considerations, based on the use of each of the methods in a large number of cases, are also discussed.

It is concluded that of the methods used, namely,

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