REFRESHER COURSE FOR GENERAL PRACTITIONERS

INTESTINAL WORMS

BY

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There are comparatively few inhabitants of this country who do not at some time in their lives harbour a worm, while indigenous peoples in the Tropics are seldom without one. Worms infecting man are of three classes: the Cestodes, or tapeworms; the Trematodes, or flukes; and the Nematodes, or roundworms. Of these, infections with cestodes and nematodes are the commonest; trematode infections other than schistosomiasis rarely occur. The present article is confined to cestode and nematode infections of the intestinal tract in man.

CESTODES, OR TAPEWORMS

The Beef Tapeworm

In Great Britain and in most parts of the world the commonest tapeworm found in man is *Taenia saginata*. This occurs wherever beef is eaten. Among peoples such as the Hindus, who do not eat beef, it is virtually unknown. The adult measures 3–4 metres in length, it attaches itself to the mucosa of the upper part of the small intestine by four suckers, and is divided into approximately 1,000 segments. The segments near the head are small and immature, the most distally placed, however, measure approximately 1.4 cm. in breadth by 2 cm. in length, and are equipped with male and female genital organs. Mature segments are motile when separated from the parent worm, and within each the uterus can be seen. The latter consists of a central stem from each side of which radiate between 18 and 30 branches. There is no communication between the uterus and the exterior, so that the eggs contained within it are liberated only by the disintegration of a segment. These eggs are infective only to cattle; they are not pathogenic to man.

Life History.—Cattle become infected when they graze on pasture soiled with human excreta containing eggs or tapeworm segments. The egg on reaching the animal's stomach develops into a larva which burrows into the mucosa, reaches a small blood vessel, and is then carried in the blood till it is held up in muscle or other organs. Here it develops into a cyst—the cysticercoid stage—and it is this cyst which is infective to man. On reaching the intestine of man the outer portion of a viable cyst is digested and the embryo within it develops into an adult worm.

Prevention.—Hygienic measures preventing the soiling of pastures by human excreta are most important. Thorough cooking will kill any cysticerci present in meat; many infected patients state that they have been in the habit of eating underdone beef.

The diagnosis of the infection is usually made by identifying segments passed in the faeces, and this is facilitated by placing one between two microscope slides, holding to the light, and examining with a hand lens. The lateral uterine branches appear milky white and may readily be counted. If there are more than a dozen the species is *T. saginata*, if less than this number it is *T. solium*. Eggs of *T. saginata* may be found in the faeces, but they cannot be distinguished morphologically from those of *T. solium*.

Symptoms of infection with *T. saginata* are usually few, and, in spite of popular belief, a ravenous appetite is very uncommon. Some patients may complain of dyspepsia and occasionally of nausea and vomiting. Most of those infected, however, seek medical advice because they have seen segments in the stool or because segments have passed

through the anus by means of their own motility at times other than during defaecation. Occasionally the faculty of independent movement causes segments to become impacted in the appendix, with resulting local inflammatory disease.

T. saginata is the most difficult large tapeworm to expel, and unless the head is removed the parasite will grow again during the succeeding two to four months. As intestinal contents surrounding the worm may prevent the anthelmintic from reaching it, an important preliminary to treatment is to empty the alimentary canal as completely as possible. This also facilitates the identification of the head if it should be passed, there being little faecal material present to complicate the search. Accordingly for three days the patient should be given bland fluids without any solid food other than a finger of toast thrice daily. Magnesium sulphate, $\frac{1}{2}$ oz. (14 g.), should be administered each morning during this period of starvation, and it is advisable for the patient to be in bed and preferably in hospital.

Extractum filicis liquidum is the most efficient anthelmintic in this infection, and the total dose for an adult is 90–120 minims (6–9 ml. approximately). This is divided into three equal parts and given at half-hourly intervals on the morning after completion of the starvation period. The extract is unpleasant to take and is therefore commonly supplied in gelatin capsules. As these may be carried past the head of the worm before their contents are liberated, it is advisable to prick the ends of the capsules before swallowing, or to give the drug in a draught. A prescription for the latter is ext. filicis liq., 90–120 minims (6–9 ml.); syr. zingib., $1\frac{1}{2}$ dr. (5.2 ml.); and aq. menth. pip. to $1\frac{1}{2}$ oz. (42 ml.). A still better method is to bring the anthelmintic directly in contact with the worm by duodenal intubation. After the usual starvation a Ryle's tube is swallowed and the patient is instructed to lie on the right side. In one-half to two hours the end of the tube is usually carried through the pylorus, though it is advisable to check its position radiologically. Two hours after the extract has been given a saline purge is administered (usually $\frac{1}{2}$ oz. (14 g.) of sodium or magnesium sulphate). This serves the double purpose of expelling the worm and the anthelmintic once it has done its work. Little of the anthelmintic is therefore absorbed and toxic reactions are accordingly reduced in frequency.

In most cases the worm is passed between 2 and 12 hours after administration of the anthelmintic, and the head may be found at this time or during the succeeding two days. If, however, the head is not recovered it is unwise to repeat the course of treatment with filix mas until three months have elapsed, as the drug is toxic. A safe procedure is to give tetrachloroethylene after allowing the patient food for two days. This substance dissolves in fat and alcohol, in which it may therefore be absorbed from the intestine; the patient is accordingly placed on a low-fat diet and alcohol is withheld. Two days after the administration of the filix mas, 60 minims (4 ml.) of tetrachloroethylene is given in the morning on an empty stomach. Again administration as an emulsion or by a duodenal tube results in a higher percentage of cures than does administration in capsules. The usual saline purge is given two hours after the dose of anthelmintic. A prescription for the emulsion is tetrachloroethylene, 1 dr. (3.5 ml.); promulsin mucilage, 4 dr.

(14 ml.); spirit. menth. pip., 15 min. (1 ml.); aq. chloroform. to 2 oz. (57 ml.). Following treatment all stools are saved for 48 hours or until the head is found. Good results have recently been claimed for treatment with mepacrine; after the usual preliminary starvation, 100 mg. (1½ gr.) of mepacrine is given at intervals of five minutes until 1 g. (15 gr.) has been administered. A saline purge is given two hours later.

Other Tapeworms

Infections with *T. solium* are fortunately rare in this country. In treating them great care should be taken regarding disposal of faeces, as the ova, unlike those of *T. saginata*, are infective to man. In human tissues and brain they are able to develop into the cysticercoid stage of the parasite, and the cysts in the brain may cause epilepsy. *T. solium*, as well as the fish tapeworm *Dibothriocephalus latus*, may be expelled by the treatment already outlined. A curious, though uncommon, complication of infection with *D. latus* is severe megaloblastic anaemia. The worm apparently absorbs vitamin B₁₂, and if attached high up in the small intestine may divert this to itself before the human host has been able to absorb it. If situated some distance from the pylorus the host absorbs enough vitamin B₁₂ to prevent anaemia before the intestinal contents reach the worm. Extracts of *D. latus* have been shown to have a high content of haemopoietic factor and to induce maximal reticulocyte crises in patients with pernicious anaemia.

NEMATODES, OR ROUNDWORMS

Of the family of Nematodes, or roundworms, the three commonest members infecting man are *Ascaris lumbricoides*, *Ancylostoma duodenale* (a hookworm), and *Enterobius vermicularis*, or the threadworm.

Ascariasis

Ascaris lumbricoides is not uncommon in Great Britain, though it is more prevalent in tropical countries. Infection is acquired by swallowing mature ova, which are usually conveyed on food and especially on uncooked vegetables. In the intestine the ova hatch out into larvae, and these, after burrowing into the intestinal mucosa, enter small blood vessels and are carried to the lungs, where they leave the blood stream and burrow through lung tissue till they reach a bronchus. They travel up the bronchus and trachea, over the epiglottis, and are then carried down the oesophagus to the intestine, where they mature into adult worms. The adult worms resemble earthworms in outward appearance, an adult male measuring approximately 25 cm. (10 in.) in length and an adult female 40 cm. (16 in.). A female ascaris passes approximately 200,000 eggs daily and 27 million during its lifetime. The infection is diagnosed by recognizing these eggs in the faeces. Occasionally an adult worm may be passed in the faeces or be vomited. Prophylaxis depends on preventing the contamination of soil by human excreta and, if this cannot be ensured, on the avoidance or thorough washing of vegetables eaten uncooked.

Bronchopneumonia may result from the passage of larvae through the lungs, but this is unusual unless a large number of ova are swallowed at one time. It is possible for a heavy infection to develop from swallowing small numbers of ova at intervals without the occurrence of lung symptoms. In light infections symptoms attributable to adult worms seldom occur, though occasionally there may be colic and the wandering habits of the worms may take them to the stomach, whence they may be vomited. Rarely they enter the appendix, common bile duct, or even the Eustachian tube. In some patients an allergic dermatitis occurs, presumably owing to the skin becoming sensitized to the worm's products. In heavy infections balls of worms may cause intestinal obstruction, particularly in children, and in those living on a poor diet worms may aggravate the state of malnutrition.

Treatment of Ascariasis

Several drugs are available, and the safest and most effective is hexylresorcinol. The adult dose is 1 g. (15 gr.), that for children of 2 to 4 years 0.4 g. (6 gr.) to 0.6 g. (10 gr.), and for those of 5 to 12 years 0.8 g. (12 gr.). Those older than 12 may be given the adult dose. The drug is taken in the morning, the patient having had nothing to eat since 6 p.m. on the previous day; it is advisable to follow the drug in two hours by a saline purgative. Hexylresorcinol is usually dispensed in capsules containing 0.2 g. (3 gr.), and these should not be bitten, otherwise the escaping contents will irritate the buccal mucosa. Tetrachloroethylene may be substituted for hexylresorcinol in an otherwise unchanged regime, but a disadvantage of this drug is that before killing the worms it stimulates them to great activity, and in children this might result in perforation of the bowel. In contrast to the treatment of tapeworms, there is not here the same necessity for an effective therapeutic action near the pylorus. Administration by duodenal tube or in an emulsion is therefore unnecessary, and the dose of 4 ml. (1 dr.) for an adult is most conveniently administered in gelatin capsules. Santonin has long been used in ascariasis, the adult dose being 0.2 g. (3 gr.) to 0.3 g. (5 gr.). This is administered nightly for three nights along with 0.12 g. (2 gr.) calomel, no special dieting being required. In some patients, even when small doses are administered, vision is disturbed, everything appearing either yellow or green. Fortunately this disturbance is rapidly rectified on discontinuing treatment.

Recently diethylcarbamazine ("hetrazan" or "banocide") has been used against this worm, and good results have been claimed. It may be given in tablets or in syrup. If the former are used the adult dose recommended is 18 mg. per kg. body weight daily for five days, the total daily dose being divided into three individual doses. Administered in the syrup, a single dose of 13 mg. per kg. body weight is given daily for four days.

Hookworms

Infections with the hookworm *Ancylostoma duodenale* are widespread throughout the Tropics and occasionally may be contracted in the temperate zone. In Great Britain this was the commonest worm infection found among troops and prisoners of war returning from the Far East. The male worm measures approximately 1 cm. by 500 µ, the female 1.2 cm. by 600 µ. The related species *Necator americanus* is slightly smaller and is widely distributed in the New World and in Africa. The worms may live for as long as six years, and it has been estimated that females produce up to 20,000 eggs a day. These eggs on reaching warm damp earth develop into larvae which are able to penetrate the unbroken skin. Infection is usually acquired by walking on such earth while wearing inadequate covering to the feet; very occasionally larvae may be swallowed. They bore through the tissue till they reach a blood vessel and are then carried in the blood to the lungs. There they burrow into alveoli and then migrate via the trachea and oesophagus to the duodenum, where they develop into mature worms, become attached to the intestinal mucosa, and feed on blood. The diagnosis is made by demonstrating the eggs in the patient's stool. Direct examination of fresh preparations will reveal all but very light infections, and for the latter concentration methods are available. In prevention, hygienic measures to limit contamination of soil by human faeces are of the utmost importance. The wearing of adequate covering to the feet and ankles will do much to prevent infection.

Symptoms are produced by the larvae penetrating the skin, by blood loss, and occasionally by the presence of worms in the intestine. The penetrating larvae irritate the skin and dermatitis usually occurs, often linear tracks may be seen, and the regions most affected are those between and adjacent to the toes and around the ankle. This dermatitis usually settles down without treatment in a few days.

Occasionally human skin may be invaded by larvae of *Ancylostoma braziliense*, a hookworm normally infecting dogs and cats. When this occurs a more chronic form of creeping eruption results. These larvae are unable to develop into adult worms in man.

The presence of adult hookworms in the duodenum seldom gives rise to symptoms, though occasionally mild dyspepsia may occur. The anaemia resulting from heavy infections is the main cause of debility and develops especially in those living on a poor diet deficient in protein. Its severity depends on the number of worms present and the adequacy or otherwise of the patient's diet. Among well-fed individuals even moderately heavy infections may be symptomless and the haemoglobin normal. Moderate degrees of anaemia are common among infected indigenous peoples in the Tropics, and severe anaemia is not infrequent among those who are malnourished. These anaemias are usually of the microcytic hypochromic variety, though it has been suggested that macrocytosis may result when the infected individual is obtaining enough iron in the diet. Helminthic infections in general and hookworm infections in particular may aggravate malnutrition in those on a poor or borderline diet.

Treatment should be directed to expelling adult worms and restoring to normal the blood picture and the state of nutrition. For the first, hexylresorcinol or tetrachloroethylene, used as for ascariasis, are equally effective. The latter readily responds to ferrous iron preparations and a well-balanced diet rich in protein.

Threadworms

Enterobius vermicularis is especially common in children and has a world-wide distribution. The female measures 1 cm. by 600 μ , compared with a mere 4 mm. by 150 μ in the male. The male dies after fertilizing the female, which migrates to the peri-anal region nightly and there deposits large numbers of eggs. These adhere to the skin in glutinous masses and are infective 36 hours after deposition. On being swallowed by man, the eggs develop into adult worms in the small intestine; an intermediate host is not required. Infective ova may survive in household dust and particularly in dust from the bedclothes of infected persons. Heavy infections are unlikely to arise from swallowing dust, but this mode of infection probably accounts for some of the extremely chronic infections met with from time to time.

The diagnosis may be made by finding worms in the faeces, and this is facilitated by giving a mild purgative. Ova may be demonstrated in material scraped from the peri-anal skin, a sharp spoon being used for the purpose. The National Institute of Health (N.I.H.) cellophane swab has been found of great value. It is fixed to a glass rod with a rubber band, and for use is moistened, rubbed over the peri-anal skin, and then transferred to the laboratory in a test-tube. The cellophane is spread out on a slide and examined directly for ova under the microscope.

During their wanderings on the peri-anal skin the female worms cause irritation which leads to scratching and which may disturb sleep. Through scratching, eggs may be conveyed to the mouth on fingers and behind the nails. As no intermediate host is required very heavy infections may be built up in this way. Appendicular inflammation occasionally results from migration of the worms.

Numerous remedies have been tried, but none are so effective as simple hygienic measures. The worms live for only three to six weeks, and if no ova are swallowed the infection will die out within this period. The most important single measure is to scrub the hands, including the nails, before every meal and after defaecation. The nails should be kept short. With the object of killing worms as they deposit ova on the peri-anal skin, this region should be smeared nightly with ung. hydrarg. ammon. Close-fitting pants worn at night will prevent any eggs laid from being scattered among other garments and bedclothes and mixing

with household dust. These pants should be boiled immediately after use, and before beginning treatment bedclothes should be changed. Small nightly enemata of 2-4 oz. (57-114 ml.) of normal saline will rid the rectum and anal canal of worms likely to migrate during the night and will therefore prevent pruritus and contamination of fingers by ova.

Hexylresorcinol given in the dosage already stated is probably as effective as any anthelmintic, though unless treatment with it is combined with hygienic measures incomplete eradication of worms usually results.

Trichiniasis

Trichinella spiralis is commonly found in rats, occasionally in pigs, and man may be infected by eating undercooked infected pork. Outbreaks of trichiniasis in Wolverhampton and London in 1940 and 1941 were traced to the use of uncooked sausage meat as a sandwich spread. In the intestine the worm matures and bores into the mucosa, liberating larvae into small blood vessels. The larvae are disseminated throughout the body and encyst in a wide variety of organs. A peculiarity of this parasite is that its larvae encyst in the host harbouring the adult.

Symptoms are very variable, gastro-intestinal irritation and diarrhoea usually result from the presence of the worms in the intestine, and pyrexia, muscular pains, urticaria, and oedema from the disseminated larvae. Unfortunately only symptomatic treatment is of any value. Human infections can be prevented by thoroughly cooking pork, those in pigs by destroying rats, and by keeping pigs in rat-proof enclosures.

Other Roundworms

Strongyloides stercoralis and *Trichuris trichiura* are intestinal worms less commonly affecting man than those already described. In all but heavy infections symptoms are slight or absent, and this is fortunate, as no known treatment is effective in eradicating them.

Discussion

Patients conscious of harbouring worms are usually impatient to have them expelled. It should be remembered, however, that their expulsion is not usually a matter of urgency and that all anthelmintics are toxic and treatment may be debilitating. It is usually wise, therefore, to postpone treatment of pregnant women till after parturition and of those ill from non-helminthic diseases till there is no longer a risk of their condition being aggravated by the treatment.

Treatment of helminthic infections in children may be difficult, as they often are unable to tolerate adult doses of drugs, yet the worms present may be fully grown. To children more than 12-14 years old, however, full doses of anthelmintics can usually be given, to those aged 5-12 years two-thirds to four-fifths of the adult dose, and to those aged 2-4 years one-half to two-thirds of the adult dose. Below the age of 2 years helminthic infections other than with threadworms are rare, and these may be adequately treated without the use of drugs.

Physicians are not uncommonly called upon to allay patients' unreasonable fears concerning helminthic infections. Worms appear to have a special psychological significance and an unusual ability to inflict psychological trauma. The latter is often out of all proportion to the physical disturbance produced. In some individuals this "alarm reaction" will be called into play by seeing in the faeces vegetable fibres superficially resembling worms; fortunately a brief microscopical examination will put the physician in a position to reassure such patients.

In children with convulsions the possibility of a worm infection being responsible is not uncommonly raised. Although convulsions have been ascribed to such infections, it is doubtful whether it is correct to do so except in cysticercosis, schistosomiasis, trichiniasis, and hydatid disease, in which larval forms of the worm may occur in

the brain. When convulsions occur in infections other than these, therefore, the possibility of their being due to idiopathic epilepsy should be carefully examined.

An eosinophilia usually accompanies the migration of larvae through the tissues. In the early stages of infection with worms in which such larval migrations occur an eosinophilia, often of marked degree, is present in the blood. A differential white blood cell count may therefore be of diagnostic value in infections with *Ascaris lumbricoides*, hookworms, *Trichinella spiralis*, and *Strongyloides stercoralis*. An eosinophilia also occurs in infections with *Trichuris trichiura*, schistosomes, and filariae, and if the contents of cysticerci are absorbed after death or after being damaged.

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Reports of Societies

HEART DISEASE AND PREGNANCY

Professor J. CRIGHTON BRAMWELL'S presidential address to the Manchester Medical Society on October 7 was on heart disease and pregnancy.

The risk of pregnancy in patients with heart disease depended, he said, on the severity of the disease. It could be assessed in most cases by the patient's tolerance for exercise prior to pregnancy. In patients whose heart disease was trivial the risk was negligible; in those whose tolerance for exercise was limited to a greater or lesser extent the added risk was appreciable; while in those who had suffered from heart failure the risk was considered prohibitive. Pregnancy was contraindicated in patients with active rheumatic carditis and in those whose cardiac condition was deteriorating rapidly. Intercurrent infections, especially bronchial infection and anaemia, were important and preventable causes of heart failure.

Chance of a Live Baby

The prospect of successful pregnancy must also be considered. In a recent series of 500 cases four out of five pregnancies had yielded living children, whereas in 53 patients who had advanced heart disease seen too late to terminate pregnancy, or who were unwilling for it to be terminated, only one in four was successful.

Acute pulmonary congestion in patients with mitral stenosis constituted a grave emergency which was liable to develop very suddenly and often proved fatal. If recognized in the first trimester, pregnancy should be terminated. Valvotomy was now a possible alternative to termination of pregnancy. In addition to the clinical evidence, x-ray screening was invaluable in the early recognition of this condition. Auricular fibrillation did not add so greatly to the risk as most earlier workers had imagined. Under favourable conditions it should not be regarded as a bar to pregnancy. In patients who had never actually had heart failure, but whose tolerance for exercise was considerably limited, assessment of the risk was most difficult, and factors other than the severity of the heart disease—namely, age and parity, temperament, and economic conditions—all had to be taken into consideration. The addition of an aortic lesion to mitral stenosis did not add to the risk. Opinions varied about the importance of cardiac enlargement, but many patients who died of acute pulmonary oedema had little cardiac enlargement. A case follow-up had shown that about 90% of patients who survived exhibited no evidence of cardiac deterioration as the result of pregnancy.

Treatment

Professor Bramwell believed that the two most important considerations in treatment were never to interfere with pregnancy in a patient with heart failure until everything possible had been done to relieve the heart failure, and, secondly, to ensure adequate antenatal supervision in every case. If heart failure was recognized early it responded well to treatment. In the antenatal clinic the almoner played a most important part. It was now known that blood volume and cardiac output diminished in the last few weeks of pregnancy, and that the strain on the heart was correspondingly reduced. There was therefore no cardiac justification for anticipating normal delivery by the induction of premature labour or caesarean section. All recent workers agreed that, in patients with heart failure, caesarean section carried a heavier mortality than normal delivery.

AETIOLOGY OF TROPICAL SPRUE

Sprue has always been difficult: it is an affliction of long-drawn-out misery, hard to treat and harder to understand. Its affinities with idiopathic steatorrhoea and coeliac disease are superficially obvious, and have often been emphasized. But we are still far from understanding the origins of all three. In his address to the Royal Society of Tropical Medicine and Hygiene on October 16, Professor A. C. FRAZER clarified some of the obscurities in a lucid account of investigations on all these conditions. There seems to be no doubt about the depressed absorptive capacity of the small intestine, which is not associated with any demonstrable organic lesion. There is, however, clear radiological evidence of increased secretion of mucus, and although this may be taken to indicate a catarrhal condition of the small intestine its precise significance is not yet clear. It is associated with decreased motility.

Professor Frazer could not answer the aetiological riddle of sprue, but suggested that the condition might be due to the use of rancid unsaturated fats. Rancidity might be present without affecting taste, and the geographical distribution of sprue coincided with areas where unsaturated fats are extensively used—it was rare where palm oil is a staple food. Rancid fats could cause steatorrhoea and increase secretion of mucus; the subject was now being investigated. He did not dismiss the idea of infection, which occurred to so many of the people who had observed the distribution of sprue in the Forces in India during the war, but there was no direct evidence of it. An association of coeliac disease with wheat gluten was clear and precise.

Professor A. W. WOODRUFF agreed that the vitamin-deficiency theories of the primary causation of sprue were untenable, and briefly stated the reasons why the disease known as sprue in the Caribbean might not be true sprue, but rather a megaloblastic anaemia of nutritional origin. Professor B. G. MAEGRAITH referred to his own experimental work on mepacrine, which in high dosage could give the same radiological picture of excessive secretion of mucus as Professor Frazer had described. He thought that the basic defect was in the absorption of fat, and had found absorption of glucose normal in some cases. Dr. F. D. ROSENTHAL emphasized the importance of failure of appetite in precipitating the onset of symptoms in the cases he saw in Hong Kong.

The Central Council for District Nursing in London is perturbed that the general public is not aware that 10% of the cost of running the home nursing service has to be provided by voluntary contributions. The demands on the service are continually increasing, and it would be unfortunate if its voluntary status were lost by lack of the necessary funds. It is felt that many of those who use the service would be pleased to make a donation if they were aware of the facts, and the Central Council would be most grateful for any assistance in this connexion. Donations should be sent either to the local associations or to the Central Council.