twelve recurrences recorded, all took place after an interval of one month or more from cessation of treatment for the previous attack ; one case had had two previous attacks.

Conclusion

In my opinion the introduction of the benzyl benzoate treatment is an important advance in the treatment of scabies, and it is particularly valuable where large numbers are infected. The ease and speed with which the applications can be carried out, the absence of unpleasant effects apart from a temporary prickly sensation during the painting process, the rapidity of cure, and the almost immediate relief from itching combine to make it a satisfactory remedy from both the clinical and the public health aspects.

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THE TRANSMISSION OF SCABIES

BY

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There has been a good deal of controversy concerning the way in which scabies is transmitted. Much importance has been attached to blankets, and an extreme view is expressed by Lydon (1941), who says that, at least in the Army, "it cannot be stressed too strongly that blankets are the chief means of spread of scabies infection, and unless strict control is instituted cases will continue to appear in their present numbers." The view that blankets are a common method of transmission is widely held in the Army, and the first reply made to the medical officer by the scabies patient when questioned concerning infection usually suggests that blankets were concerned—even from men recently on leave to homes ridden with the disease. On the other hand, certain workers, particularly those in France, have considered that scabies is primarily spread by personal contact, and have suggested that it may be considered as a venereal disease. Working under controlled conditions, Munro (1919) has shown that scabies may be transmitted by fomites, but his results do not indicate how often such transmission is likely. The experiments described here are part of an investigation to find out exactly how the disease is normally transmitted.

These experiments were made using volunteers who lived under controlled institutional conditions and who were subjected to different types of contact with scabies infection. The volunteers were all pacifists who had offered to co-operate in this work and who, during the experiments, received board and lodging and a weekly payment similar to that which they would have received had they been called up for military service. They agreed to submit themselves to infection and to allow the course of the disease to be followed on their persons. Throughout the experiments the volunteers co-operated loyally, and I have had no reason to suspect that all instructions were not always conscientiously carried out. The expenses of the investigation were paid by the Ministry of Health.

Experimental Work

Fomites.—The volunteers were put in contact with blankets and underclothing previously used by scabies patients. Care was taken to use fomites only from patients about whom there was no doubt of the diagnosis of scabies. Where bedding was used it had normally been in contact with the patient for several weeks, and for the last twenty-four hours before transfer the two inside blankets in contact with the patient were the same as those subsequently in contact with the volunteer. In most of the experiments using blankets alone the volunteer was naked so as to ensure contact. The volunteer never bathed for a period of at least a fortnight after the beginning of an experiment ; and later, when it was felt that it might be a disadvantage for him to start with too clean a skin, bathing was prevented for a further week before the experiment started. Bedding and underclothing were used by the volunteers for a period of seven days, the bedding being slept in at night only, whereas the underclothing was worn continuously, day and night. In the earlier experiments the blankets and underclothing were kept for periods of several days under conditions of known temperature and humidity. I hoped thereby to discover how climatic conditions influenced the infectivity of the materials. When a dozen or more experiments had been made without infecting the volunteers it was thought best to work under conditions which would appear to offer the maximum chance of infection. The results obtained in all these experiments may be summarized as follows :

(*a*) Volunteer used blankets one to seven days after they had been used by scabies patient: 6 experiments, all negative (i.e., no volunteers infected).

(*b*) Volunteer used underclothing two to seven days after it had been used by scabies patient: 6 experiments, all negative.

(*c*) Volunteer used bed immediately it was vacated by scabies patient: 19 experiments, all negative.

(*d*) Volunteer used underclothing immediately after it was removed from scabies patient: 32 experiments—30 negative, 2 *positive* (i.e., 2 volunteers became infected).

The men were stripped and inspected daily for a period of about a month (sometimes longer) after each experiment. The inspection took several minutes, and any suspicious lesions or areas in which irritation was felt were scrutinized with a high-power lens or a binocular microscope. Although work at present in progress shows that in some cases at least seven weeks may pass before *clinical* signs of scabies develop in an infected volunteer, some signs of infection are always visible to careful inspection at an earlier date, and, considering the care with which the daily inspections were carried out, I do not think it would be possible for any inspections to have been missed. Furthermore, the same men were used throughout the whole series of experiments, so that a slowly developing case would have eventually been detected.

Personal Contact.—When two infected volunteers were at last obtained it became possible to test the effects of personal contact. On four occasions uninfected volunteers slept together in the same beds as these men suffering from scabies. The scabies patients both had a general infection of the body (this was two to three months after their contact with infected underclothing), and the disease would probably have been detected at a routine inspection such as is commonly held in the Services, but the degree of infection was very much less than that usually seen in patients coming for treatment. The men wore pyjamas during these experiments. In three instances the volunteer and the infected man slept together for seven nights, and mites were found on all three volunteers after periods of

eight, nine, and twelve days from the start of the experiment. In a fourth case the volunteer slept for two nights under the conditions described above and did not develop the disease.

Conclusions

In 63 experiments using underclothing and blankets scabies was transmitted twice only, although everything was done to favour transmission. In none of the experiments (25 in all) using blankets alone was infection transmitted, and I think we are justified in assuming that under normal conditions blankets can seldom be responsible for the transmission of the disease. On the other hand, a small number of the experiments have shown that transmission by comparatively slight personal contact may be readily accomplished.

I believe that scabies is normally transmitted by personal contact either of a slight or of a venereal nature. There is no doubt that small children are often the first members of a family to be infected; the way in which children play with their arms around each other's necks suggests an easy means of transmission. Children then probably infect their mothers, who pass on the scabies to the father. An investigation of scabies in the Army shows that while a large number of cases may be traced to infection on leave, some other cases are due to illicit intercourse. It is difficult for an Army medical officer to obtain this information from a soldier, but it is possible to find out a good deal from resident patients by means of suitably chosen orderlies, to whom the patients will discourse more fully concerning their experiences. There is very little evidence to suggest that in this country scabies is being commonly spread from man to man in the Army.

One reason for the importance that is attached to fomites in scabies transmission is that lice are well known to be spread by this means, and as both scabies and pediculosis are parasitic diseases it might be expected that transmission would occur in a similar manner. As, however, the itch mite lives beneath the skin of the host during the major part of its life, and the body louse lives on his clothes, only going on to the body to feed, it is not surprising that considerable difference should exist.

The evidence given here is not sufficient to enable us to say that disinfestation of clothing and blankets is unnecessary in cases of scabies, though this conclusion seems quite probable. I hope that it may be possible for other workers, particularly public health authorities, to obtain more extensive evidence. I may add that in many cases where reinfection has been attributed to fomites one of three possibilities has not always been excluded:

1. Contact with another case of scabies (a person who is once infected is likely to continue to have the same contacts, with continual risk of infection).

2. Incomplete cure, which may take several weeks to manifest itself.

3. Certain lesions remain visible and irritant for weeks after cure, and unless living parasites are found it is dangerous to consider that a reinfection or relapse has actually occurred.

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G. D. Kettelkamp and W. W. Stanbro (*Amer. Rev. Tuberc.*, 1941, **44**, 104) state that two identical male twins were admitted to hospital with a history of common initial symptoms of pain in the left chest, cough, and expectoration. Both were treated by artificial pneumothorax. The clinical course was similar, both patients developing laryngeal tuberculosis. Both died, and the necropsy showed in each tuberculosis of the lungs, larynx, intestines, liver, and spleen.

Medical Memoranda

Carotene Preparations as Substitutes for Vitamin A Preparations

Dr. H. Steenbock of Wisconsin, U.S.A., in 1919 and Prof. Hans von Euler of Stockholm in 1928 associated the carotenoid pigments of plants with vitamin A activity. The matter was settled by Dr. T. Moore of the Nutritional Laboratory, Cambridge, when he showed that yellow carotene fed to animals is converted into the colourless vitamin A found in liver oils. There are several carotenes and allied pigments, and of these β-carotene is the most effective for the formation of vitamin A, because one molecule of β-carotene plus a molecule of water can give rise to two molecules of vitamin A. A molecule of the other carotenes can be converted into only one molecule of vitamin A. Therefore it has been assumed that the carotenes can be used as substitutes for vitamin A.

In wartime, when there is a shortage of protective foodstuffs of animal origin rich in vitamin A, dietitians urge an increased use of foodstuffs rich in carotenes, such as carrots, green leaves, red palm oil, etc.

Recently attempts have been made in India and Ceylon to find substitutes for cod-liver oil, and it has been proposed to use products of red palm oil (*Elaeis guineensis*).

A new preparation has been made in Madras: it is a thick cloudy oil of a deep orange colour, and contains 516 γ per gramme of carotene, reckoned as β-carotene. It has been submitted to the following limited test in Ceylon.

Fifteen children in an orphanage who showed marked or very marked signs of phrynodermia were divided into three groups of 5 each. The first group were given approximately 30 grammes of the preparation; the second group received 30 grammes of unstandardized cod-liver oil daily; and the third group were used as controls. The children were examined weekly, and the result at the end of six weeks was as follows: 3 of the first group showed some improvement and 2 showed none; 4 of the second group were markedly improved, with considerable clearing up of the phrynodermia, and 1 was slightly improved. None of the control group showed any improvement. All the children received portions of the same diet.

Many children with phrynodermia have been treated with capsules of a fish-liver oil concentrate, each of which the makers guarantee to contain "not less than 9,400 I.U. of vitamin A activity." It has been our experience that, with a few exceptions, phrynodermia clears up in children in about three weeks when they are given three capsules daily. The international unit of vitamin A activity is 0.6 of β-carotene, and the amount in the new preparation given daily to each child was approximately 26,000 units reckoned as β-carotene. Even assuming that much of the carotene was in the form of α- and γ-carotenes the children were receiving a very considerable amount. Incidentally, although the cod-liver oil was far more effective than the preparation, it does not seem to have been of a very high standard.

DISCUSSION

Little is known concerning the absorption of carotenes from the alimentary tract or of their conversion into vitamin A in the healthy body, and still less is known of their fate in the body under conditions of disease. There may be little doubt that a healthy adult on a vegetarian diet can obtain a sufficiency of vitamin A from the carotenes of the diet; but it does not necessarily follow that this applies to the infant or the growing child. There is a high incidence of signs of vitamin A deficiency among the poorer-class children of Ceylon, and this is especially so among the younger children and those being weaned to a more or less vegetarian diet. It seems as though the metabolism of the child's body does not quickly or readily pass from the utilization of vitamin A as it occurs in the mother's milk to the utilization of carotenes by converting them into vitamin A.

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