

the contents of one and a half benzedrine inhalers, an unorthodox but readily available source of the drug.

One case developed an acute psychosis, a common feature of severe amphetamine intoxication which requires heavy barbiturate sedation both for prophylaxis and for treatment.

We thank Dr. Clifford Hoyle for his guidance and for permission to publish these cases. We are also indebted to Dr. P. H. Connell (Maudsley Hospital) for estimating the amphetamine excretion in two of the cases and for much valuable advice.

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TRICHOPHYTON RUBRUM INFECTION IN FAMILIES

BY

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Trichophyton rubrum is the fungus most often isolated from patients with mycotic skin diseases attending the Bristol Royal Hospital. Of the 12 species isolated from 204 of these patients seen in the two years since March, 1954, *T. rubrum* was found 43 times.

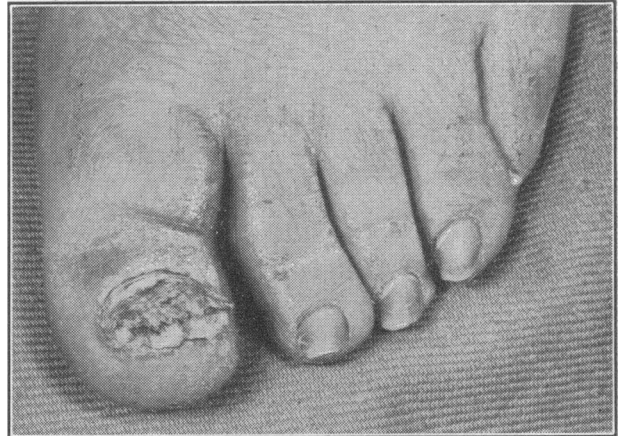
The infection is usually first noticed as a scaling or macerated area between the toes indistinguishable from tinea pedis due to other fungi. *T. rubrum* differs from other dermatophytes, however, in that it is much more likely to attack the nails, when their discoloured, misshapen, and broken appearance (see Fig.) may cause the patient much mental distress; treatment at this stage is very rarely successful. It is surprising, therefore, that the epidemiology and prevention of the disease have been so neglected.

Literature

Baer *et al.* (1955) showed the ease with which infective particles can be shed from active mycotic lesions of the feet. After they had soaked the infected feet of 73 patients in footbaths for 15 minutes they were able to demonstrate the presence of fungi microscopically in the water from 54 of the baths, and to obtain cultures of pathogenic fungi from 13 of these. Despite this evidence, these authors deny the importance of cross-infection in the spread of the disease, on the grounds that numerous attempts, by themselves and others, to isolate pathogenic fungi from

supposedly contaminated floors have been generally unsuccessful. Recently, however, Gentles and Holmes (1956, personal communication), using a new technique, have been able to isolate from the floors of four pit-head bathhouses the species of fungus predominant in the feet of the bathing miners at each pit.

Numerous surveys have been carried out on the incidence of tinea pedis in many types of community, but little effort has been made to trace the spread of any one fungus. Peck *et al.* (1944), on examining the feet of workers in six factories, found only five cases of *T. rubrum* infection, and all these occurred in the same plant. Gentles and Holmes



Trichophyton rubrum infection of the toe-nails.

(1956, personal communication) produce strong evidence that the habitual use of communal baths is an important factor in the spread of tinea pedis in coal-miners. The infection rate with all species of fungi is 31% of miners using baths against 8% of those who do not. They also found that, among bathing miners, the proportion of the two most important pathogens varied from pit to pit: in eight pits *T. mentagrophytes* was the predominant fungus; in one, *T. rubrum*; and in the tenth the two species were present in almost equal numbers. These figures indicate the importance of cross-infection in a community.

On the other hand, Hopkins *et al.* (1947), investigating fungous infection of the feet of soldiers at a military post, found that the various species occurred in approximately the same ratio in most of the groups examined, and concluded that individual susceptibility to an existing latent infection was more important than exposure to cross-infection. However, three of their 26 groups show considerable variation from the predominant species ratio and four others show slight variation. It is possible that the rapid turnover of personnel in military establishments would often allow insufficient time for any one species to become dominant.

Sulzberger *et al.* (1942) attempted to assess the extent of familial and conjugal infections of the feet and groins by sending questionnaires to over 100 American dermatologists. They concluded that among "a sum total probably aggregating hundreds of thousands of patients with fungous infections" of these areas, only four cases of familial infection were proved, and that therefore such infection was of no practical importance. The authors rightly consider that familial infection is not proved unless the fungi are isolated and shown to be culturally similar; yet they include as relevant the replies of 82 dermatologists who did not attempt cultural methods of proof, as well as those of the six who did. Also, no evidence is offered that any of these dermatologists had, as a routine, examined the family contacts of all their ringworm patients, and unless this was done their data can be of little value.

Referring to family infection by *T. rubrum*, Hyman (1953) does not believe that there is any evidence for its existence, while Lewis (1953) thinks it is fairly common, an opinion

which is supported in this country by Gold (1954). Several case reports of familial infections with this fungus have appeared (Hodges, 1921; Lewis and Spoor, 1953).

In view of these conflicting opinions I have tried to determine the incidence of familial *T. rubrum* infections in normal home conditions by a small survey of families living in the Bristol area.

Methods

The 32 patients from whom *T. rubrum* had been isolated and who were living with their families were asked to take part in the survey. As well as households consisting of parents and children, the families included adult brothers and sisters living together, and couples with no children at home. Two families refused to co-operate, five had left the district, and six were found, for various reasons, to be unsuitable subjects. Observations were made on the remaining 19 families comprising the original patients and their 48 contacts. They were visited on prearranged evenings, with the result that it was usual for the whole household to be present at the interview. The survey was undertaken during the winter of 1955-6.

The Interview.—The feet and hands of all persons present were examined and if there were clinical symptoms scrapings were taken. Personal histories were noted and family circumstances and habits discussed.

Laboratory Methods.—The skin scrapings were examined microscopically in 15% potassium hydroxide solution and cultured on Sabouraud's glucose-agar with added penicillin and streptomycin, cultures being obtained from all but one of the microscopically positive specimens but never from those which were negative. When more than one member of a family was infected, the isolates were compared with regard to growth rate and macroscopic and microscopic characters on six agar media (Sabouraud's glucose; Sabouraud's preserve; cornmeal; cornmeal + 1% glucose; asparagine-glucose; and nutrient + 4% glucose) on which they were grown for four weeks at 29° C. Distinct and persistent cultural differences, however slight, were taken to indicate the possibility of different strains which the patients might have contracted from different sources.

Results

The Spread of Infection.—In 9 out of the 19 families more than one person was infected with *T. rubrum*, and within each of these families the isolates were mycologically of the same type. In addition to the communal strain, variant strains of the fungus, occurring in the same lesions, were isolated from two of the families. Of the 48 contacts examined, 13 (27%) were infected, and in 11 of these the infection was first noticed in the feet. The minimum duration of exposure before any of these contacts showed signs of the disease was one year, but one girl was exposed for 15 years before infection was apparent. A much larger survey would be necessary to discover accurately the proportion of children brought up in infected families who ultimately contract the disease; but eight subjects between the ages of 14 and 35 years had been exposed as children, and six of these had proved infections.

Environment and Spread of Infection.—According to the Registrar-General's social classification, 11 of the families belonged to social classes I and II, the disease having spread in six; five were in class III, with a disease spread in two; and three were in classes IV and V, with a disease spread in one. The numbers are small, but they could indicate that *T. rubrum* mycosis is a disease mainly of the professional classes. Alternatively, it is possible that the working classes are less likely to seek medical advice about such a condition. Social class did not influence the incidence of spread, extension of infection having occurred in about half the families in each group. Two of the families were overcrowded, one being spotlessly clean and the other filthy, and together they accounted for 16 of the persons interviewed; yet, in each, only one contact had contracted the disease.

Seven of the original patients could trace their initial infection to residence or active service abroad, and in four others the disease was first noticed while the patient was using swimming-baths regularly or taking an active part in sports. The remaining eight could describe no special circumstances which might have accounted for the onset of their infection.

Effect of Precautions.—Five families had for three years or more taken precautions against spreading the disease—for example, they avoided walking about with bare feet, exchanging footwear, or using a communal bath-mat; and if they shared a bed they wore socks. The infection had not spread in any of these families after the precautions were instituted. It must be noted, however, that two wives who had taken no precautions had not contracted the disease, though they had been exposed to their husband's infections for 30 years.

General Observations on the Infected Persons

In an analysis of all the 32 infected persons seen during the survey (the 19 original patients and the 13 infected contacts) the following points were observed:

1. There was an almost equal sex incidence (17 males to 15 females).
2. Conjugal infection had occurred in 4 out of the 15 couples seen.
3. One child had contracted the disease before he was 5 years old; five first showed evidence of infection between the ages of 5 and 13, and seven persons when they reached 14 years or over.
4. In 27 patients the initial infection was in the feet; in the other five, the hands alone were involved in four, and one child had only a lesion on the face.
5. The nails were infected in 25 persons (78%); in four the finger-nails only had been attacked, in 15 the toe-nails only, and in six both finger- and toe-nails.
6. Three women and four men had had groin infections. Ringworm of the groin in women has seldom been reported in this country, and a description of these cases will be given elsewhere. One woman described ringworm of the axilla and one had an extensive infection of the arms and legs; four cases of ringworm of the face and body were seen.
7. Dermatophytes other than *T. rubrum* were encountered only twice, each time in association with the latter fungus. One man had a severe infection of the feet and toe-nails from which mixed cultures of *T. rubrum* and *Epidermophyton floccosum* were isolated; he had infected his daughter with the former fungus only. One woman had *T. rubrum* on her hands, contracted while treating her son's infection, and *T. interdigitale* on her feet.

8. Twenty-three patients had been referred for specialist advice, but only one while the infection was confined to the toe-webs. Of the remainder, seven consulted a dermatologist when their finger-nails became involved; five each about groin and toe-nail infections; four about face and body lesions; and one about lesions on the hand. Yet in 18 of these infection of the toe-webs had preceded by many years the more widespread symptoms.

Discussion and Conclusions

This survey indicates the importance of cross-infection by *T. rubrum* in the home. In half the families the malady had spread, and 27% of the contacts who were examined were infected. A number of them were unaware of their infection, and this emphasizes the importance of personal examination of such people rather than merely questioning them or their relatives. In fact, these figures are probably an underestimate of the extent of the disease, for in addition to the verified cases many persons interviewed gave descriptions of typical ringworm of the body in the past and mentioned other members of the family who had left home whose toe-nails were "all yellow and thickened."

Marples and Di Menna (1949), Baer *et al.* (1955), Gentles and Holmes (1956, personal communication), and others have noted the long period of exposure before clinical infection of the feet becomes evident: this, as I have reported, has also been my experience. The evidence indicates that some breakdown in personal immunity must precede the onset of clinical disease. If a person is to become infected, this lessening of immunity must coincide with inoculation with a viable fungus. In contradistinction to the hypothesis that patients become infected after recent inoculation from an outside source, Sulzberger *et al.* (1942) and Sulzberger and Baer (1955) believe that most supposedly normal persons are carriers of fungi, and that this is the starting-point of clinical disease when immunity breaks down. Their theory is not supported by the evidence of familial infection in 11 of my 48 contacts, while only one had contracted the disease (due to *T. interdigitale*) from an outside source: a larger proportion of extraneous infections, or at least of mixed infections with two species, would have been expected. The evidence indicates continual exposure of the contacts to cross-infection in the home and a phase of lowered personal resistance which allowed the fungus to produce clinical disease.

The intractability of *T. rubrum* infections to treatment, their disfiguring nature, and the mental distress which often ensues emphasize the importance of attempting to check the spread of the disease. This is especially so in families with young children, as is shown by the infection rate of six out of eight persons over the age of 14 who had been exposed to infection as children. Precautions should be simple and have the object of preventing the shedding of infective particles in places where others may come into contact with them; for instance, avoiding walking about bare-footed, exchanging footwear, or using a communal bath-mat. The sterilization of footwear and floors is impracticable and is not likely to be performed faithfully by the patient.

In half the patients who had been referred to dermatologists the disease had already reached the nails, and was therefore practically incurable. If more patients with tinea pedis were seen by dermatologists before this stage was reached, and if the fungus concerned was identified, infection of the nails and hands might be delayed or prevented. For should *T. rubrum* be found, the patient could be warned to pay greater attention to his condition than is normally accorded to "athlete's foot."

Summary

The epidemiology of *Trichophyton rubrum* infections has been studied in 19 families in whom one member was known to be infected.

The disease had spread in nine of the families, and 13 (27%) of the 48 contacts were infected. The mycological similarity of fungi isolated from members of the same family has been demonstrated.

Six out of eight persons over the age of 14 who had been exposed to infection during childhood had contracted the disease.

Periods of exposure of from 1 to 15 years were noted before clinical signs of disease occurred, and in five families who had taken precautions for three years or more there had been no spread of infection.

The nails had been attacked in 78% of all the infected persons. In most of these the disease had begun in the toe-webs, but specialist advice had not been sought at this early stage.

Cross-infection with *T. rubrum* in families is important, and simple precautions against spreading the disease are suggested.

I thank Dr. R. P. Warin and Dr. C. D. Evans, whose patients, except for one family, were the subjects of this inquiry, for their enthusiastic support throughout; Dr. Catherine J. Maclaren, who

most kindly interviewed one family of her own patients for me; the families, for their very helpful co-operation; and Dr. M. Hewitt for his invaluable guidance in the preparations for, and conduct of, the survey and in the presentation of the results. I am indebted to the University of Bristol Medical Photographic Department for the photograph.

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ATHLETE'S FOOT FUNGI ON FLOORS OF COMMUNAL BATHING-PLACES

BY

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During a recent survey of foot ringworm in groups of industrial workers in Great Britain, Gentles and Holmes (1955, 1957) showed that there is spread of infection among users of communal bathhouses. Parasitic fungi were isolated from the floors of some of the bathhouses on a number of occasions (Gentles, 1956). There was some indication that these fungi were not present as saprophytic colonies on the floors, but the evidence was not conclusive (Gentles and Holmes, 1955; Gentles, 1956). Various opinions on the method of spread of infection have been given. Duncan (1949) and J. T. Ingram (1954, personal communication) believed that spread took place by transfer of scales from the feet of the infected to the interdigital clefts of the feet of others. Duncan also believed that the fungi could grow saprophytically on wooden floors, and Riddell (1951) stated that the increase in incidence of the disease amongst users of communal bathing-places was probably due to the lighting up of latent infections rather than to new infections caused by the fungi growing saprophytically on the floors. Peck, Botvinick, and Schwartz (1944) stated that the pH of aged concrete was compatible with growth of the dermatophytes concerned, but they did not show that growth actually took place, and the dermatophytes they isolated from sterilized concrete probably came from infected skin fragments (Gentles, 1956).

Adamson and Annan (1949) isolated *Trichophyton mentagrophytes* from a fragment of skin found on the floor of a bathhouse, and I also made one isolation in this way (Gentles, 1956).

Experiments recently carried out in this laboratory have confirmed that spores of *T. mentagrophytes* can exist for long periods on concrete surfaces and also that this species of dermatophyte can grow on moist crushed asphalt when soap is present. It seems unlikely, however, that the conditions required to enable growth to take place are ever fulfilled in practice. It is customary for floors of most institutions to be thoroughly cleaned at frequent intervals (usually daily) with detergents and disinfectants of various kinds, and these substances almost without exception exert a fungistatic action on