Epidemiologic Study of Tinea Capitis *caused by* T. tonsurans and M. audouinii

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AT THE ringworm clinic of the Wayne County Health Center, Eloise, Mich., during the last 6 months of 1959, the causative agent in 23 of 74 cases of tinea capitis in children was proved by culture to be *Trichophyton tonsurans*. This relatively high incidence of *T. tonsurans* infection in an area not previously known to be endemic for this fungus was emphasized in an earlier report (*1*). More infected children were subsequently seen at the clinic, and a majority of these patients were students from three schools in a particular area of Inkster, Mich.

In an effort to determine the extent of this outbreak, casefinding surveys for tinea capitis were undertaken from June 1959 to March 1963 among 15 of Inkster's 22 schools, families of infected children, and patients referred to the ringworm clinic from areas outside Inkster.

School Surveys

School children were initially screened for tinea capitis by careful examination of the scalp. Any abnormal condition, such as alopecia, erythema, excoriation, folliculitis, scarring, or even small patches of minimal dry scaling, was considered suspect. The children with suspicious conditions were re-examined and studied further in special clinics held in the schools. Each child was examined under Wood's light, and specimens for culture, essentially hair and scales, were taken with tweezers. Microscopic examination of hair and scales prepared in potassium hydroxide was not performed. Precautions to avoid cross-contamination among the children and the cultures included having a sufficient number of tweezers (10 pairs), which were flamed before use and washed and immersed in 95 percent alcohol after use.

The specimens were planted on agar slants of Sabouraud's dextrose medium with chloromycetin and actidione. The cultures were left at room temperature, and the resulting fungal growth was identified. The children with cultures positive for dermatophytes were followed up and treated in the ringworm clinic.

The distribution of the 22 schools in Inkster is shown in figure 1. Three school surveys were conducted. The first, in April 1960, included the three schools (Nos. 11, 12, and 15) attended by many of the infected children seen at the ringworm clinic before the survey and four adjacent schools (Nos. 17, 18, 19, and 20). The second survey, in March 1961, was limited to the kindergarten and first-grade classes of Nos. 11, 12, and 15. A more extensive survey, in May 1962, included eight more schools (Nos. 3, 4, 7, 8, 9, 13, 14, and 16), for a total of 15 schools.

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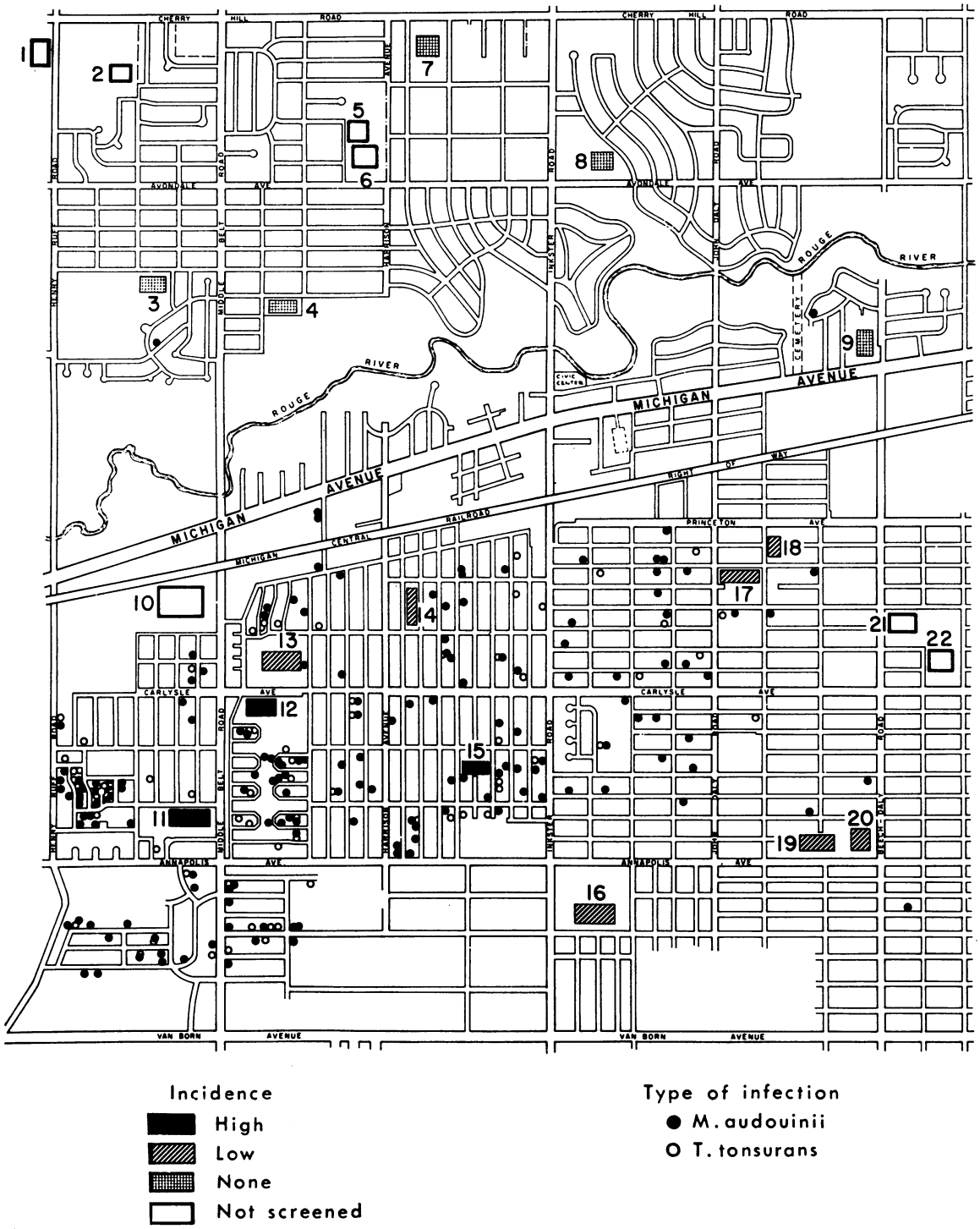
Figure 1. Location of schools and domiciliary distribution of children infected with Microsporum audouinii or Trichophyton tonsurans, Inkster, Mich., June 1959–March 1963



Family Followup

During the 1960 survey, special clinics were established in the schools to examine the families of the children with positive cultures. The families of other infected patients seen at the ringworm clinic were examined at that facility.

Pertinent familial epidemiologic data were gathered by interviews and questionnaires. The data included information on barbering; moviegoing; use of school buses; sharing of headgear, combs, and brushes; extent of association and play with other children; presence of known scalp infection among neighborhood children; and animal pets. Special efforts were made to trace the origin and movements of families, including visits of relatives from other areas.

Results and Discussion

A total of 434 children had positive cultures for tinea capitis; 82 percent were from Inkster, and the remainder had been referred to the ringworm clinic from nearby communities in Greater Detroit.

Mixed infections were observed in 19 children; 18 had both *T. tonsurans* and *Microsporum audouinii*, and 1 had *T. tonsurans* and *Trichophyton violaceum*. The causative agents isolated and their frequencies were:

Agent	Infected children	
	Number	Percent
M. audouinii	278	64.1
T. tonsurans	142	32.7
M. canis	8	1.8
T. violaceum	6	1.4

M. audouinii is known to be endemic in the Greater Detroit area, and it has caused epidemics of scalp infections. Tinea capitis caused by *T. tonsurans*, however, had not been reported previously from this area. Its occurrence in almost a third of the infected children substantiates predictions of its spread from endemic centers in the southwestern States to other parts of the country. It is also indicative of the dynamic nature of the flora of tinea capitis, which differ from region to region and sometimes even in the same locale. Ajello (*2*) has attributed the changes in geographic distribution of the dermatophytes to "various forces, such as climate, man's social and antisocial activities, his cultural habits, his migrations, and the developments in therapy."

School surveys. The results of the school surveys, summarized in table 1, confirmed the initial observation that many of the infected children were from the three schools, Nos. 11,

Table 1. Results of school surveys for tinea capitis in Inkster, Mich., June 1959–March 1963

School Nos.	1960				1961 [1]			1962				Total		
	Total enrollment	Clinically positive	Positive for *M. audouinii*	Positive for *T. tonsurans*	Clinically positive	Positive for *M. audouinii*	Positive for *T. tonsurans*	Total enrollment	Clinically positive	Positive for *M. audouinii*	Positive for *T. tonsurans*	Clinically positive	Positive for *M. audouinii*	Positive for *T. tonsurans*
11	743	107	18	14	53	[2] 10	4	650	89	6	[2] 7	249	[2] 34	[2] 25
12	681	84	19	15	26	1	2	651	111	2	2	221	22	19
15	527	60	16	3	37	11	0	471	53	3	2	150	30	5
19, 20	1,042	27	6	0				1,021	34	11	0	61	17	0
17, 18	807	26	3	0				801	45	5	3	71	8	3
14								235	15	2	0	15	2	0
13								663	7	0	2	7	0	2
16								287	50	1	0	50	1	0
9								413	7	0	0	7	0	0
8								568	19	0	0	19	0	0
7								233	24	0	0	24	0	0
4								406	8	0	0	8	0	0
3								489	5	0	0	5	0	0
Total	3,800	304	62	32	116	22	6	6,888	467	30	16	887	114	54

[1] Only kindergarten and first-grade students surveyed.

[2] Includes 1 case previously detected.

12, and 15. Of the seven schools surveyed in 1960, *T. tonsurans* was observed in only these three schools; in 1962, in only these and two adjacent schools. The affected schools serve contiguous areas and are in the same school district (fig. 1). The absence of infection in the surrounding schools indicated that the outbreak, though sizable, was as yet localized. The total enrollment of the seven schools initially screened in 1960 was 3,800. Clinical scalp changes were seen in 304 children. Cultures from 32 of these were positive for *T. tonsurans.*

The 1961 survey of the kindergarten and first-grade children uncovered six more children infected with *T. tonsurans.* This suggested that extramural factors also operate in the spread of the infection. During the more extensive survey in 1962, which covered 15 schools with a total enrollment of 6,888, cultures from 16 (half as many as in 1960) of 467 clinically suspected children were positive for *T. tonsurans;* 1 of the 16 infections had been previously detected. This reduction in incidence may be attributed in part to the public and personal health measures instituted and to effective treatment with griseofulvin.

Initially, the main interest in the school survey was detection of *T. tonsurans* infection. Soon after the survey began, however, we noticed that infection caused by *M. audouinii* was not only present in the same schools, but even more rampant. We then realized that this simultaneous occurrence of both infections to an appreciable extent in the same population segment afforded a singular opportunity for comparative studies of certain epidemiologic aspects. A number of excellent school surveys for tinea capitis have been performed elsewhere, but these were concerned with outbreaks caused by *M. audouinii.*

Race distribution. Among all the cases of tinea capitis seen at the ringworm clinic and those detected in Inkster, both *T. tonsurans* and *M. audouinii* infections occurred overwhelmingly in Negroes. The distribution was:

Agent and race	*Ringworm clinic*	*Inkster*
T. tonsurans:		
Negro	140	125
White	2	0
M. audouinii:		
Negro	258	219
White	20	4

However, no definite conclusion can be drawn regarding racial susceptibility to these infections because of the racial composition of the population screened. The three schools, Nos. 11, 12, and 15, where most of the cases were detected had an almost exclusive Negro student population. Adjacent schools, Nos. 13, 14, and 17, with fewer cases, had both Negro and white students. The schools which were free from infection, Nos. 3, 4, 7, 8, and 9, had a white student population.

Sex distribution. As shown in the following tabulation, boys were more frequently affected by both types of infection than girls.

Agent and sex	*Ringworm clinic*	*Inkster*
T. tonsurans:		
Boys	100	93
Girls	42	32
M. audouinii:		
Boys	214	172
Girls	64	51

In the ringworm clinic the ratio of boys to girls for *T. tonsurans* was 2.1 to 1, and for *M. audouinii*, 3.3 to 1. In Inkster the ratios were 2.9 to 1 for *T. tonsurans* and 3.4 to 1 for *M. audouinii.* The higher incidence of *M. audouinii* infection among boys is generally attributed to their more frequent physical contact at play and other activities, more sharing of headgear, shorter hair, and less personal hygienic care.

Carrick (*3*), in a survey of tinea capitis caused by *M. audouinii* among school children in Detroit, found an incidence among boys nearly six times that among girls. *T. tonsurans* infections, however, have been reported to occur with more or less the same frequency in boys and girls (*4, 5*), but far more frequently among women than men (*4–7*).

Age distribution. The incidence of both types of infection in the ringworm clinic and in Inkster is shown by age in table 2. Most of the children infected with *M. audouinii* were from 5 to 8 years of age; those with *T. tonsurans*, from 4 to 10 years. Both infections peaked at 6 years of age and had essentially similar curves of age incidence in Inkster, as shown in figure 2. Among all the infected children, the oldest with *T. tonsurans* infection was a 17-year-old girl. Four 13-year-old children were the oldest infected with *M. audouinii.* Despite the known tendency of *T. tonsurans* infection to persist to

adulthood, none of the adults screened in the family followup studies had this infection. This fact suggests that the outbreak was fairly recent when it was discovered. Both infections occurred in 1-year-old children.

Geographic distribution. The domiciliary distribution of the children with *M. audouinii* infection overlapped that of those with *T. tonsurans* (fig. 1). Both infections showed greater conglomerations around the affected schools, indicating that the outbreak was localized. Occasionally, both infections appeared in the same home and even in the same member of the family as double or mixed infections. The families in the affected area are predominantly Negro. In certain sections of the area, corresponding to concentrations of cases, large families live in overcrowded housing developments which have substandard sanitation facilities. Considerable mobility of the population takes place within the area.

Family data. Family followup studies revealed a familial incidence. The 278 patients with *M. audouinii* infection represented 199 families, and the 142 patients with *T. tonsurans* represented 78 families. The 78 families had a total of 412 children. All the children in 2 families, 1 with 4 and 1 with 5 children, were infected; 4 families, each with 5 children had 4 infected children apiece; and in 1 family 9 of 11 children were infected.

The times when clinical changes appeared were usually such that a definite chain of infection could be traced; infection in the school-age child was generally followed by infection in his preschool sibling. The intrafamily spread of infection may be attributable to continuous contact; sharing of combs, brushes, towels, and headgear; and home barbering. Personal hygiene was inadequate; many of the patients' families used little soap and water, particularly on the scalp.

The spread of infection from family to family probably results from physical contact among neighborhood children during play in and out of school. Barbering and the backs of seats in school buses and movie theaters have also been implicated in the spread of tinea capitis. The children of one-third of the families affected with *T. tonsurans* used neighborhood barbershops, which were fairly well controlled by the authorities. A number of families, however, patronized amateur itinerant barbers. Less than half of the families attended movies,

Table 2. Distribution of children with tinea capitis caused by Trichophyton tonsurans and Microsporum audouinii, by age, in ringworm clinic of Wayne County Health Center and Inkster, Mich., June 1959–March 1963

Age (years)	Ringworm clinic [1]				Inkster			
	T. tonsurans		*M. audouinii*		*T. tonsurans*		*M. audouinii*	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	2	1.4	6	2.2	2	1.6	5	2.2
2	5	3.5	9	3.3	5	4.0	9	4.0
3	7	4.9	18	6.5	5	4.0	14	6.3
4	11	7.7	22	7.9	9	7.5	17	7.6
5	13	9.1	44	15.8	11	8.8	32	14.3
6	27	19.0	46	16.5	26	20.8	40	17.9
7	20	14.0	33	12.2	17	13.6	27	12.1
8	18	12.6	37	13.3	17	13.6	28	12.5
9	15	10.5	26	9.3	11	8.8	22	9.8
10	12	8.0	20	7.2	11	8.8	16	7.1
11	5	3.5	9	3.3	5	4.0	7	3.1
12	4	2.8	4	1.4	4	3.2	3	1.3
13	2	1.4	4	1.4	2	1.6	3	1.3
17	1	.7	0	0	0	0	0	0
Total	142		278		125		223	

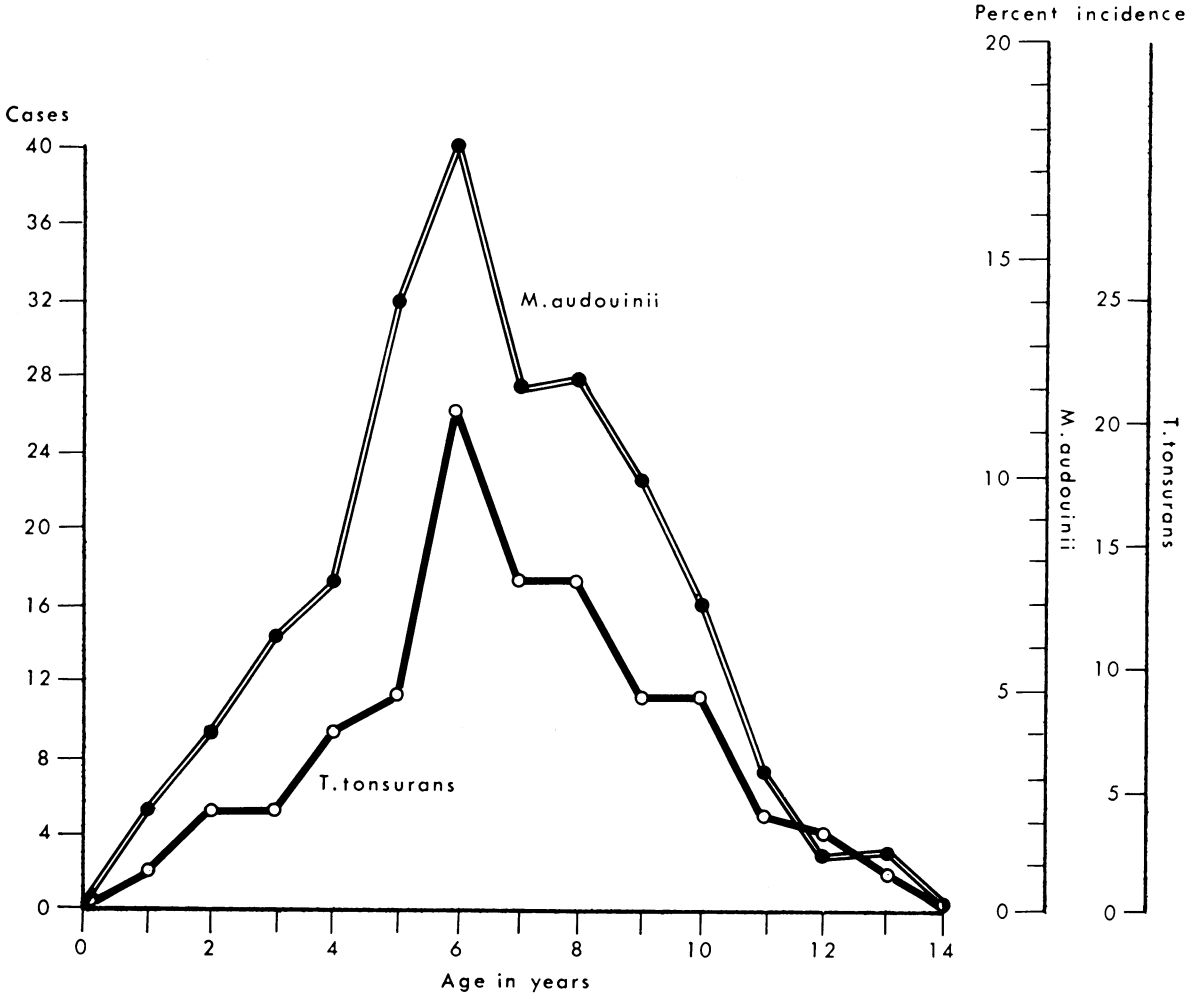
[1] Numbers and percents include those for Inkster.

and few used the school buses. Most of the families did not have animal pets.

Population movement has been indicted as the major vehicle for the spread of *T. tonsurans* infection from endemic foci to other areas. Therefore, we studied the origins and movements of the affected families for a reasonable period in an attempt to trace the original infection responsible for the outbreak. Most of the families, including one from Mexico, had been long-time residents in the area and could not afford the cost of vacations to other places. Four families had recently migrated from the South, one each from Mississippi and Alabama and two from Arkansas. A few families had vacationed in southern States, and one in California and Mexico; but they could not recall any association of their children with others who might have had scalp infections. Also, no definite clues could be uncovered from the history of visits of relatives from endemic areas.

According to authorities in the city government and the Michigan Employment Security Commission, no migrants had been working in the Inkster area. In fact, migrant workers had been discouraged from coming because of an existing pool of excess workers in the area. Nevertheless, it is possible that the area was "seeded" by an infected person or a carrier, probably from the endemic focus in the northeastern section of Michigan's Lower Peninsula. Hand and Georg attributed the introduction of

Figure 2. Age distribution and percent incidence of tinea capitis caused by Microsporum audouinii and Trichophyton tonsurans, Inkster, Mich., June 1959–March 1963



T. tonsurans infection to migrant Mexican farm, orchard, and foundry workers (*8*, *9*).

Nonfluorescent M. audouinii infection. As the school surveys progressed, more and more isolations of *M. audouinii* were obtained from children whose scalps had shown no fluorescence under Wood's light. Of the 278 children with positive cultures for *M. audouinii*, 115 (41 percent) were negative by Wood's light examination. Two important factors may possibly explain these unexpected isolations: (*a*) airborne contamination of the culture tubes or contamination of uninfected children by use of improperly sterilized instruments, or (*b*) the possibility that the children were either in the carrier state or in the prefluorescent stage of the infection.

Ajello and associates (*10*) considered similar findings indicative of actual, but nonfluorescent, *M. audouinii* scalp infections. The existence of this nonfluorescent type of *M. audouinii* infection and the increasing incidence of the also nonfluorescent *T. tonsurans* infection obviously diminish the value of Wood's light in the diagnosis of tinea capitis and make the use of culture techniques imperative.

Control measures. Attempts to control the outbreak were based mainly on treatment of infected patients with griseofulvin. Most of the patients were treated in the ringworm clinic, only a few by private physicians. During the first 6 months of the project, we tried to determine the smallest possible dose of griseofulvin that would be effective. Patients were first given 125 mg. to 250 mg. daily. It soon became evident, however, that the therapeutic response to these dosages was too slow. Thus, by 1960 the average dose was increased to 500 mg. daily, and subsequently to 1,000 mg. per day. This larger dose seemed to shorten the course of treatment and reduce the total dosage required for cure.

The responses of the children to griseofulvin therapy varied widely. The total dosage required for mycologic cure (at least 2 successive negative cultures 2 weeks apart) ranged from 3.5 to 112 grams. A few patients were cured after 1 to 2 weeks of drug therapy; others required up to 3 months. For 100 patients with *T. tonsurans* infection, the average dosage of griseofulvin was 28 grams and the average period of administration was 6 to 8 weeks. Generally, the patients with *T. tonsurans* infection required a greater total dosage of griseofulvin and a longer time for cure than patients with *M. audouinii* infection; relapses were more frequent with the *T. tonsurans* infection.

Particular effort was devoted to educational aspects of the control measures in order to enlist cooperation from school teachers, school nurses, parents, private physicians, and health department personnel. Parents and children were apprised of the importance of adequate personal hygiene, especially frequent and thorough cleaning of the scalp and avoidance of common use of combs, brushes, and headgear. Infected children were admonished not to participate in play activities requiring physical contact with other children.

By 1962 an appreciable decrease was seen in the number of tinea capitis patients at the ringworm clinic, and by 1963 the outbreak seemed to have subsided. However, since a few children with *T. tonsurans* infection were still being encountered, the infection apparently had become endemic. Continued vigorous and extensive casefinding is necessary to detect and treat the residual or overlooked infected children, so that they can be eliminated as potential sources of further dissemination of the infection.

Implications of findings. In 1952 several authors pointed out that the increasing incidence of *T. tonsurans* was becoming a public health problem in established endemic areas of the southwestern States, particularly Texas and southern California (*5*, *7*, *11*, *12*). They also expressed apprehension about its spread to other sections of the country. Subsequent reports have borne out their fears, and the outbreak reported here constitutes another step in the journey of this fungus. Population movements, particularly among migrant farm and factory workers, are strongly suspected as the major medium of transmission. Continuous surveillance is necessary in the Inkster area to prevent the infection from spreading to adjacent as well as distant areas. Zackheim (*13*) has noted an increasing incidence of *T. tonsurans* infection in Detroit.

The results of the analysis of the concomitant appearance of both *M. audouinii* and *T. tonsurans*, which indicated that age, sex, and geo-

graphic distribution of children infected with either of these fungi were essentially similar, suggest that certain epidemiologic factors operate similarly for the two infections. This adds credence to the portent that *T. tonsurans* infection, if not controlled, may range the country as did *M. audouinii.*

Summary

An outbreak of *Trichophyton tonsurans* infection among tinea capitis patients seen at the ringworm clinic of the Wayne County Health Center, Eloise, Mich., during 1959–60, led to the observation that most of the patients were students from Inkster, Mich. To determine the extent of the outbreak, casefinding surveys were undertaken from 1960 to 1962 among schools in Inkster, families of infected children, and patients referred to the ringworm clinic from areas outside Inkster.

The surveys detected a total of 434 children with tinea capitis. The causative fungi, proved by culture, were: *Microsporum audouinii* in 278 children (64.1 percent); *T. tonsurans*, 142 (32.7 percent); *Microsporum canis*, 8 (1.8 percent); and *Trichophyton violaceum*, 6 (1.4 percent).

The high incidence of *T. tonsurans* infection in an area not previously known to be endemic for this fungus indicated that it had spread from known endemic centers. The simultaneous appearance of *M. audouinii* and *T. tonsurans* infections in the same population segment, with similar sex, age, and domiciliary distributions, suggested similar epidemiologic factors in their spread.

Of the 278 children with positive cultures for *M. audouinii*, 115 were negative by Wood's light examination. The existence of this nonfluorescent type of *M. audouinii* infection and the increasing incidence of *T. tonsurans* infection lead to the conclusion that culture techniques are imperative in the diagnosis of tinea capitis.

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