This paper reports observations of the decline of prevalence and incidence of infections of school children by the fungus, Histoplasma capsulatum, in Milan, Michigan, and will consider the factors which appear to be associated with this decline.

OBSERVATIONS ON THE DECLINE OF HISTOPLASMAL INFECTIONS IN SCHOOL CHILDREN: MILAN, MICHIGAN, 1958-1968


Background

In May of 1958, histoplasmin testing of children attending school (kindergarten through 12th grade) in the principal communities of Washtenaw County, Michigan, brought to light a focus of hyperendemic sensitivity to histoplasmin in Milan,1 where about 61 per cent of 1,300 school children had positive histoplasmin tests. In the other communities, the relative frequency ranged from about 3 per cent to 11 per cent, with an average of about 8 per cent for some 7,800 children. Subsequent histoplasmin testing of children in the Milan School District at approximate six-month intervals from May, 1959, through October, 1962, was done on a selective basis.

Epidemiologic investigations were begun in August, 1959, and by August, 1960, the point source of the fungus dissemination was tentatively identified as being located within the bounds of a starling roost, which included a portion of the bare earth area on the north side and to the rear of the public Junior High School.2 Preliminary results of soil sampling during the remainder of 1960 gave sufficient support to the hypothesis to prompt the Washtenaw County Health Department to recommend to the Milan District Board of Education, in February, 1961, that an attempt at control be initiated. The method recommended was that of covering the bare earth area at the rear of the school building with asphalt. The rationale of this method was to create an impervious barrier between the fungus colonies in the soil and the external environment. Thus, dissemination of spores from the school ground should be reduced, with a corresponding reduction in the risk of human infection by inhalation of the spores.

During August, 1961, this recommendation was carried out, but only to the extent of paving the eastern two-thirds of the area. In the summer of 1962, the remaining one-third of the area was covered with grass sod in order to reduce the volume of dust production from that site. Meanwhile, the school authorities placed restrictions on the area for use as a playground and as a parking area for the school buses.
By October, 1962, there was a dramatic fall in the incidence of new histoplasmal infections in school children, as evidenced by the drop in conversion rates. It was then agreed to discontinue testing until 1968, when a skin testing program would be undertaken in a fashion as nearly identical as possible to that of May, 1958, in order to determine whether the decline in infection rates would be sustained.

The present report will document the evidence derived from the testing program of April, 1968, and compare it with evidence from earlier testing programs.

Methods

Histoplasmin testing was offered to all children attending school in Milan in April, 1968. Testing was again done by a team from the Southeastern Michigan Tuberculosis Detection Project. The same technique of application and standards of reading were used, as well as antigen from the same source as in May, 1958. The record of each participating child was then matched against the record file accumulated from all of the previous skin testing programs, in order to identify those tested as well as the results of the tests made at some time prior to April, 1968.

The data were then analyzed so as to permit two types of comparison: (1) relative frequency of prevalence of positive histoplasmin reactions of April, 1968, versus those of May, 1958; and (2) relative incidence of skin test conversion (taken as evidence of first infection) during the interval between the test of 1968 and the most recent of tests prior to it.

Results

The methods and coverage of the testing program of April, 1968, differed in no significant manner from that of May, 1958. Children who completed skin testing made up 69.2 per cent of the estimated total enrollment in the schools. This figure is to be compared with the average of a 70 per cent completion rate for skin testing in the county schools.

Prevalence of Positive Tests

There were 1,652 children who had technically satisfactory tests; 201 or 12.2 per cent had positive reactions, a proportion which is the maximal estimate of the prevalence ratio in those tested. However, of the 201, a total of 76 had been recorded as being positive at an earlier time; we believe these should be removed from consideration since they were not at risk of first infection over the interval between tests. Removal of the 76 from both numerator and denominator results in the minimal estimate of the prevalence ratio, or 8.1 per cent.

By comparison with May, 1958, when the prevalence ratio was 61.2, there has been a dramatic decline in this index of histoplasmal infection; the decrease has been in the order of five to eightfold or, expressed as per cent reduction, 80-85 per cent.

When the prevalence ratios specified for the available identification characteristics of tested children are examined, it is found that the decline has been quite uniform. Reductions of the same order of magnitude are seen within each of such variables as sex, race, place of residence, school attended, grade in school, and use of the school bus system. Significant patterns of prevalence ratio distribution such as were seen in the May, 1958, testing are no longer evident.

Probably the most telling piece of evidence is that prevalence ratios in Milan school children as of April, 1968, are now 8.2 per cent, i.e., in the same order of magnitude as the average.
prevalence ratios of all children tested in other county schools in May, 1958.

**Incidence of Conversion**

Of the children tested in April, 1968, 268 had been tested at some earlier period and were negative at the last test prior to April, 1968. Of these, 19 or 6.6 per cent had become positive by 1968. However, the period between tests varied between six and ten years so that the 19 conversions had occurred during 2,180 person-years of observation. Inclusion of the time factor results in a conversion rate of 0.87 or approximately 1 per 100 person-years.

During an earlier phase of the study, the over-all incidence rate of conversion for the period from May, 1958, to May, 1960, was shown to be 25.0 per 100 person-years. This permits an estimate of the reduction of the impact of infection as being about 25-fold or 96 per cent.

From the data made available through the 1968 study, no significant pattern of conversion rates in relation to the identification variables is to be seen. There is, in fact, a marked degree of uniformity within the range of 0.30 to 2.22 conversions per 100 person-years. This is in marked contrast to the patterns of 1958-1960 when there was a significant degree of association of conversion with several variables, as shown in Table 1. As will be seen from the first part of the table, conversion was conspicuously associated with attending classes in the Junior High building, riding the school buses, or living near the Junior High. By 1968, there was no association; all the rates are now of the same order of magnitude, one similar to that of children who neither attended classes in the Junior High nor rode the school bus from May, 1958, to May, 1960.

An even more striking contrast is that of children in the seventh grade in the Junior High in 1967-1968 with a group of fourth-grade children who attended classes in the Junior High during the school year of 1958-1959, and who used the playground equipment located within the limits of the point source; the respective conversion rates were 0.37 and 66.7 per 100 person-years. The reduction in rates is in the order of 99 per cent.

**Discussion**

It appears that the problem of histoplasmal infections in Milan, as reflected in school children, has been reduced in magnitude in the order of 85-95 per cent. Such a reduction is probably the maximum which can be demonstrated by the methods used here. Children attending schools in other communities of Washtenaw County, when tested and retested with histoplasmin over the period from May, 1958, to May, 1960, had an average conversion rate of 3.8 per 100 person-years. This figure is somewhat higher, but not significantly so, than that of Milan school children retested in 1968.

It can hardly be denied that there has been a dramatic reduction in

<table>
<thead>
<tr>
<th>Rode school bus at some period</th>
<th>Attended classes at Junior High building at some time</th>
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<td>Did</td>
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<td>Children retested May, 1958-May, 1960</td>
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<td>Did</td>
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<td>Children retested April, 1968</td>
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<td>Did</td>
<td>0.9</td>
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*Of the 11 converters making up this rate, 10 lived within one block radius of the Junior High School.
the impact of histoplasmal infection on children attending school in Milan. During the observations reported here, there appear to be four factors associated with the decline of infection rates; there may be other factors but we have not been able to identify them. The associated factors are:

1. Covering of the formerly bare earth area of the backyard of the Junior High with asphalt and grass;
2. Removal of the school buses to another site for parking;
3. Removal of play equipment and restrictions on the use of the backyard area for recreational use by children;

The first should reduce the opportunity for escape of histoplasmal infectious elements in the dust and mud and their transportation into the school building, into the buses, and about the neighborhood. (We have no direct evidence that the organism was carried into the school or buses, but the fungus was recovered from a sample of dust obtained from the vacuum cleaner bag in a house immediately across the street from the school yard at the time it was being asphalted.) This measure, then, would have its principal effect in the suppression of dust formation and of soil transportation from the school yard portion of the point source.

The second factor should reduce the amount of dust coming from the point source and entering the buses parked behind the Junior High.

The last two factors should have the effect of reducing the opportunity of school children for contact with the point source as well as reducing the amount of time spent on the school grounds. At the time of the recognition of the problem, the Junior High regularly housed the sixth through the ninth grades; as mentioned earlier, it occasionally housed other grades as needed. After control measures were established, this school housed only the seventh and eighth grades. This latter change means that children progressing in a normal fashion through the public school grades now spend only two school years in the Junior High whereas, in earlier years, they spent at least four and perhaps more years there.

Unfortunately, there is no way of evaluating the relative proportion contributed by each of these factors to the reduction of risk of infection. Under the circumstances it was not possible to set up an experimental system which would permit such evaluation. It is our considered opinion, however, that these four factors must be taken into account in assessing the possible reasons for the decline in histoplasmal infection rates over the period of observation.

From the accumulated knowledge of the epidemiology of histoplasmosis, it seems reasonable to believe that the first factor was probably the most important and that the other factors had a reenforcing effect, if any. Still other factors, which we were unable to observe or identify, may have played a role. Other schools which may have a similar problem, may not be able to readily implement the control measures undertaken in Milan. Each point-source problem should be considered individually.

Concern must be expressed over the possible deterioration of effect of the first control measure. The asphalt has become checked and cracked and pot holes are developing; the grass cover is being worn away in spots. The possibility of increasing dust production and dispersion must be considered. It is fortunate that a new school is being built, outside of town at some distance from the point source, that will replace the Junior High as a classroom building. However, the point-source area within the present school grounds will continue to be a potential threat, especially if construction or extensive earth moving is done there. The integrity of the cover should be restored or, if soil moving...
operations are planned, the area should first be treated with 3 per cent formalin solution, using the technique of Chin and Tosh.4

Summary

Observations are presented on the decline of infections by Histoplasma capsulatum of children attending school in Milan, Michigan, between May, 1958, and April, 1968.

It is estimated that the decline has been in the order of magnitude of 85-95 per cent.

Identified are four factors or control measures (direct or indirect) thought to be associated with this reduction. It is reasonable to believe that their net effect has been one of limiting the dissemination of the spores of the fungus from the point source as well as limiting the amount of time and degree of contact with the point source by school children.

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REFERENCES

4. Personal communication from Drs. Tom D. Y. Chin and Fred E. Tosh, Kansas City Field Station, National Communicable Disease Center, Kansas City, Kansas.

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