Epidemiology and control of enterobiasis in a developmental center

ABSTRACT ● **Objective** To determine if enterobiasis could be controlled in a developmental center. ● **Design** Population-based study. Annual screening of all residents by perianal swabs for enterobiasis and on admission or discharge. Treatment of infected residents and their contacts with mebendazole, 100 mg orally, with two doses given 14 days apart. ● **Main outcome measures** The number of residents with enterobiasis and the cost of the program. ● **Results** The prevalence of enterobiasis fell rapidly and progressively, from 21% before mass medication to 1% after 3 years. ● **Conclusion** Mass medication of residents with enterobiasis and their contacts was beneficial, harmless, and cost effective.

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Enterobius vermicularis (pinworm) is a common helminthic infection, affecting almost 1 billion people worldwide from all socioeconomic classes.[1-5] In the United States, it affects 20 to 42 million people,[1] with a high prevalence among children,[6,7] institutional populations,[8-12] homosexuals,[1] and family contacts.[1-4] Enterobiasis may remain asymptomatic or cause perianal pruritus, insomnia, restlessness, irritability, and rarely, impetigo of scratched skin, vulvovaginitis, or enuresis.[1-5] Although effective medications have been available for decades, control of enterobiasis has been difficult because of reinfection, incomplete cure of infected people, and its ready transmissibility.

When some people are infected by a readily communicable disease, the entire population is placed at risk. This risk can be minimized by the mass treatment of people exposed to the index cases.[13,14] Several researchers have experimented with mass medication for enterobiasis,[8,11,15] but their studies have been marred by high rates of reinfection,[8] lack of a cost-benefit analysis,[8,11,15] short follow-ups, and inadequate surveillance data.[11,15] Consequently, mass medication has not become the standard of care. We describe our positive experience with mass medication, a 3½-year follow-up with surveillance, and a financial analysis.

PARTICIPANTS AND METHODS

This study was performed at a long-term care facility for people with developmental disabilities (mental retardation, epilepsy, cerebral palsy, and autism).[16] A third of the residents need skilled nursing care, and the rest live in intermediate-care units. Since the 1970s, when intestinal infections were endemic, all residents have been screened for *E vermicularis* by single perianal swabs annually and on admission or discharge. Specimens are collected by the swab-in-a-tube (Falcon Swube; Becton Dickinson, Franklin, NJ) paddle. Before shower or defecation, the tacky paddle is pressed against the anus. The paddle is examined by direct low-power (×10) light microscopy. The eggs of *E vermicularis* measure 50 by 20 µm; they are elliptic with a thick, smooth, colorless shell.

We reviewed records of resident census, new admissions, and *E vermicularis* prevalence (table 1). For 1994,

Table 1 *Annual resident population, number of new admissions, and number of Enterobius vermicularis cases, by year, between 1990 and 1998**

Year	Resident census	No. of new admissions	Residents with enterobiasis, No. (%)
1990	1,097	54	262 (24)
1991	1,091	24	266 (24)
1992	1,075	30	284 (26)
1993	1,035	19	300 (29)
1994	997	5	213 (21)
1995	832	5	110 (13)
1996	752	18	24 (3)
1997	867	192	16 (2)
1998	855	15	9 (1)

*All cases occurred in ambulatory residents. Mass treatment was started in July 1995. In that year, 80 cases occurred during the first 6 months and 30 cases during the second 6 months.

we also reviewed records for residents' age, sex, race, motor abilities (ability to walk or self-propel in a wheelchair), level of mental capacity, and presence of *E vermicularis* on perianal swabs (table 2).

Until June 1995, residents with enterobiasis had been treated with mebendazole, 100 mg given orally, which was repeated after 14 days. All residents living on the same unit as the index case (contact-residents) were screened and treated if results of the screening test were positive. In view of the persistently high prevalence of enterobiasis, we initiated mass treatment, effective July 1995. The index case and all contact-residents (without prior screening) were given oral mebendazole, 100 mg, two doses 14 days apart. This was approved by our infection control committee.

We analyzed the cost of the program using certain assumptions. The population consists of 1,000 residents, 30 residents per unit. The cost of treatment is $8 per resident (2 doses at $4/100-mg dose). The treatment cost was determined only for infected residents (before 1995) and for infected residents and their contacts (after 1995). Screening cost per perianal swab (code 87177 of *Current Procedural Terminology*)[17] was estimated at $5 (two thirds of its value [$7.47] per *Medicare Fee Schedule for 1999*).[18] The cost of screening contact residents was estimated until 1995; screening was abandoned after that time. Because before 1995 many residents were infected simultaneously, we conservatively estimated that screening was needed for a mean of only three resident contacts of infected residents. For example, if 7 of a total of 30 residents were infected, screening would have been performed for only the 23 residents who had not been infected. After 1995, we made allowance for treatment of contacts. Annual, admission, or discharge screening tests were excluded from this analysis because they remained unaffected. The initial cost of mass medication in 1995 was calculated only for ambulatory residents (68% of total, according to our data) because only they were infected by *E vermicularis*.

Table 2 *Epidemiology of Enterobius vermicularis in the developmental center in 1994*

Epidemiologic characteristics	Sample size, No.	No. of cases; rate/100 persons	Odds ratio	95% Confidence interval
Sex				
Male	579	161; 28%	2.71	1.94–3.79
Female	418	52; 12%		
Age, yr				
<20	64	3; 5%	0.71	0.52–0.96
20–29	175	24; 14%		
30–39	405	97; 24%		
40–49	265	64; 24%		
50	88	25; 28%		
Race				
White	775	164; 21%	0.95	0.66–1.36
Nonwhite	222	49; 22%		
Locomotion				
Ambulatory	682	213; 31%	286.94	17.82–4,619.28
Nonambulatory	315	0; 0%		
IQ				
<20	766	169; 22%	1.20	0.83–1.74
20–69	231	44; 19%		
Total	**997**	213; 21%		

Summary points

- Enterobiasis is a common and readily transmissible helminthic infection
- Single-dose treatment has been ineffective in its control
- Two-dose mass treatment of patients and contacts helped reduce its prevalence in a developmental center
- Mass medication provided complete cure, prevented autoinfection, and treated the reservoir of undiagnosed patients

The relative risk for *E vermicularis* infection by host factors was estimated by determining the odds ratio. The risk was significant at the $P<0.05$ level if the 95% confidence intervals did not include the number 1.

RESULTS

The numbers of residents, new admissions, and enterobiasis cases for the study period are presented in table 1. The initiation of mass medication in 1995 progressively reduced the prevalence from 21% in 1994 to 1% in 1998.

All cases of enterobiasis occurred in ambulatory residents. In this subgroup, *E vermicularis* prevalence declined from 31% in 1994 to 1% in 1998. The prevalence of *E vermicularis* was significantly greater among men and older residents; it was not related to IQ or race (table 2).

The current annual program cost was lower than before mass medication (table 3). The cost of the initial mass treatment of the 68% ambulatory residents was estimated at $5,440. This excess initial expense was fully offset by savings during the first two years.

DISCUSSION

We controlled enterobiasis by interrupting the incomplete treatment and autoinfection cycle and reducing the reservoir of infection. *E vermicularis* eggs take 14 days to mature to adult worms. We prevented autoinfection by administering two anthelminth doses 14 days apart. Mebendazole can kill only the adult worm (not its eggs or larvae) by inhibiting its microtubule formation and glucose synthesis.[3,11] The surviving eggs and larvae in a host's intestines can mature to new adults in 14 days. A second dose, 14 days after the first, is crucial to kill these new adults.[11] A second dose sooner than 14 days would leave the later-maturing adults unaffected, and after 14 days, the new adults would have already produced eggs.[1-4,11]

Table 3 *Financial analysis of the mass medication program for enterobiasis**

Year, *Enterobius vermicularis* prevalence, estimated cases (No.)/1,000 residents	Cost of treatment = No. of cases treated × cost ($8) per resident, $	Cost of contact screening = No. of contacts (3/case) × cost ($5) per screening test, $	Total annual program cost for treatment and screening, $
1993, 29%, 290	2,320	4,350	6,670
1994, 21%, 210	1,680	3,150	4,830
1995†, 680	5,440	0	5,440
1998, 1%, 10‡	2,400	0	2,400
Year, hypothetic; zero prevalence	0	0	0

*For assumptions, see the description of the financial analysis under "Participants and methods"
†Gives the actual initial cost of mass treatment of all ambulatory residents.
‡Includes 290 contacts.

E vermicularis has multiple transmission modes (anus to finger to mouth, food, dust, retrograde from anus to intestine) and prolonged egg viability (14 days). Unlike geohelminths, it can reproduce in humans without passing through an intermediary soil phase. Thus, it can be readily transmitted from person to person.[1-4] In institutions, transmission is further facilitated by communal living and the residents' difficulties in maintaining good personal hygiene. This creates a large reservoir of infection that may be treated using mass medication.

Our pre-1995 strategy failed to reduce the reservoir of infection because we did not identify or treat residents who had been in contact with infected residents but did not have perianal eggs (perianal swabs identify only those with perianal eggs). Because we did not treat these "infected but undiagnosable" residents, they kept reinfecting other residents, including those who had recently been cured. Mass medication successfully reduced the reservoir of infection by killing worms in contacts who were either not screened or were infected but undiagnosable.

Our study supports the recommendation of other investigators that for the effective control of enterobiasis, all household contacts should be treated with two anthelminth doses, 14 days apart.[1,3,8,11] However, current prescribing recommendations are silent about mass medication of the contacts and recommend the use of a second dose only if the case is not cured.[19] Clearly, these guidelines should be amended.

Despite mass medication, enterobiasis has not been eradicated in our center. Moreover, it took 3½ years for its prevalence to decrease from 21% to 1%. This may be because some eggs may take more than 14 days to mature and, consequently, escape harm from the second anthelminth dose administered on the 14th day. Alternatively, some persons are being reinfected due to unhygienic lifestyles (nail biting, inadequate hand washing or perianal cleaning, and pica). It may be necessary to treat such repeatedly infected residents with three to five doses of medication at sequential 14-day intervals.[20]

Effective mass medication (like immunization or water fluoridation) must be based on three tenets: nonmaleficence, beneficence, and financial affordability.[14] First, mebendazole is effective, fairly free of adverse effects, and easily administered orally, and less than 1% is systemically absorbed. It has even been used safely during pregnancy.[11]

Second, mass medication should be a charitable act toward healthy people who would otherwise not need it (beneficence). Our strategy probably did improve the residents' life by preventing perianal itch, insomnia, and irritability.

Third, the cost of any prevention strategy should be reasonable in relation to the benefit. Mass medication saved money after 2 years (table 3). No allowance has been made in this analysis for reduced suffering and improved health—the primary benefits.

To reduce the cost of the program, we relied on screening results from single specimens. Therefore, our data slightly underestimate the actual prevalence. The collection of specimens on three consecutive days is recommended to improve diagnostic sensitivity.[1-5] Nevertheless, our data are adequate for determining temporal trends because we used the same number of specimens each year.

Before 1995, the prevalence of enterobiasis in our residents was similar to that of other reports,[8-11] except for an inexplicably low (4.5%) prevalence in a study of 3,388 adults in New York with developmental disabilities.[12] Only ambulatory residents were infected with *E vermicularis*, suggesting that residents who move about have more opportunities to contract infection through pica, from contacts during group activities, and from their greater physical ability to coordinate finger motion between their anus and mouth.

In contrast with the general population, the prevalence of enterobiasis was higher among older residents (table 2).

This paradox may be because people with developmental disabilities, like children, engage in frequent hand-to-mouth activity that facilitates infection. Once infected, the autoinfection cycle perpetuates infection. Thus, older persons end up with a higher cumulative infection because of longer exposure.

Enterobiasis prevalence decreased despite the increased number of admissions in 1997 (table 1). The reason for a higher prevalence of *E vermicularis* among male residents is unclear (table 2). A similar observation has been made in New York.[12]

Reinfection after treatment is common with enterobiasis. In one developmental center, its prevalence declined from 60% to 0% after mass medication with mebendazole, but 12% of the residents subsequently became reinfected. To prevent reinfection, general control measures (hand washing, fingernail trimming, daily perineal cleaning, pica control, housekeeping, and the use of long pajamas instead of nightgowns) should be emphasized.[5]

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