

USE OF MALATHION IN THE TREATMENT OF LOUSY CHILDREN

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During trials in areas known to have head lice resistant to organochlorines, malathion was superior to the widely used gamma-benzenehexachloride. The ovicidal and residual effects of malathion were demonstrated in practice and some laboratory investigations were made of the ability of the residual effect to protect from reinfestation. No adverse side effects were found after the treatment of nearly 3,000 children with malathion-based preparations.

Introduction

Lousiness is more prevalent than is generally realized. In Britain, the head louse, *Pediculus humanus capitis* (de Geer) is the cause of most concern, and the latest school health service report gave a figure of nearly 200,000 cases in 1968 (*The Health of the School Child* 1969). These reports are valuable for indicating trends in the level of infestation over the years, but the actual figures are known to be an underestimate. This was shown dramatically by Mellanby (1941) who completed a survey of their accuracy, and, more recently, by the results of investigations by several local authorities (e.g. Donaldson 1970). The infestation levels can be safely doubled in the light of experience gained in this type of investigation and it can be presumed, perhaps conservatively, that the true level involves 400,000 of the school population.

It is known, moreover, that the distribution of head lice throughout a human population is such that at least as many other people will suffer infestation as those of school age (Buxton 1946). Head lice reach peak infestation amongst children below school age and this is particularly pronounced in boys (Mellanby 1941). Lice are also by no means uncommon on adults. Thus, an estimate of the total population of England and Wales suffering from head lice is twice that known for lousy schoolchildren: about 800,000. There is no reason to suppose that Scotland and Northern Ireland present a greatly different picture, and another 100,000 people can be added in respect of these countries. If the body louse, *P. humanus humanus*, and the pubic or crab louse, *Phthirus pubis*, are considered, the total increases further. *P. pubis* is now much more common than the body louse and is generally increasing in incidence (Fisher and Morton 1969). Consequently, it is not unlikely that one million citizens in the UK are harbouring vermin on their persons.

A contributory cause of the high levels of infestation must be that control is handicapped by resistance to organochlorine insecticides. Body lice have been known to be resistant in many countries for some years (Wright and Pal 1965), while resistance in head lice has been demonstrated quite recently (Maunder 1971). In countries like Britain where they are rare, body lice can be controlled readily by disinfecting clothing (most conveniently, by fumigation (Busvine and Vasuvat 1966), but the only acceptable way of eradicating head lice is by application of insecticides. I now have reliable reports of clinical failure of control from over twenty different areas of Britain where γ BHC or DDT (Dicophane) were in use against head lice and it is clear that the organochlorine insecticides must be replaced. In a previous paper (Maunder 1971) I described a small trial using malathion on lousy children. This work reports more extensive trials and the phenomena arising from them.

Ovicidal Effect of Malathion

Neither DDT nor γ BHC kill louse eggs. Consequently, two treatments, spaced 8 to 11 days apart, were advisable,

although if a lotion were used (e.g. Lorexane) and the head not washed afterwards, enough insecticide usually remained to kill nymphs as they emerged. However, malathion does kill insect eggs (Goszczyńska and Styczyńska 1963), but it was not known whether a single treatment was effective in louse control. Accordingly, with the co-operation of Dr W. G. Harding, Medical Officer of Health for the London Borough of Camden, 226 cases involving all age groups were each treated with 10 ml of a 0.5% malathion solution, and a careful examination was made after 7 days. No live lice were found, but many unhatched eggs were seen, most of which would normally have hatched in the intervening period. The dark eye spot of an unhatched louse could be seen through the egg shell in a large proportion of eggs examined, and it is presumed that malathion does not prevent development to an advanced stage, but so affects the nervous system that hatching is prevented. Such eggs retain a live appearance and do not shrivel for many days. The results are summarized in Table I.

TABLE I
Clinical investigation of the ovicidal effects of malathion

Age group	Numbers treated with 0.5% lotion	Lice found alive after 7 days	Evidence of new hatchings within 7 days
Adult women	57	Nil	None
Adult men	4	Nil	None
Schoolchildren	144	Nil	None
Children under 5 years	21	Nil	None

Residual Effect of Malathion

One of the unexpected results of the application of organochlorine insecticides to the hair was the very limited residual action (Busvine *et al.* 1948). DDT and γ BHC have virtually no lasting effect as shampoos and perform little better as lotions. In a previous trial (Maunder 1971), malathion gave good residual action but the number of cases involved (59) was low. At the invitation of Dr R. J. Donaldson, Medical Officer of Health for the County Borough of Teesside, and Dr R. W. Watton, Medical Officer of Health for the London Borough of Tower Hamlets, very much wider trials were organized for which both authorities deserve much credit.

Three types of area were available, each with a reasonably high degree of infestation (7-12% of the school population). However, in one area the chances of reinfestation after treatment were strongly suppressed by an unusual combination of circumstances at the time of the trial; this effect was also present to a lesser degree in a second area. It is worth examining the areas in detail.

The low reinfestation area comprised the towns of Stockton and Eston. These are compact areas, somewhat isolated from other concentrations of population. At the time of the trial they had been subjected to what was probably the most intense antilouse propaganda ever to have been used in this country. It is doubtful if any family was unaware of the louse problem and a truly remarkable degree of soaping and combing had been performed by parents, who had started to face their responsibilities in this respect in a most commendable manner. There were still very large numbers of viable eggs, but comparatively few adult lice. Under these favourable circumstances the trial was launched, using malathion in Eston and Lorexane (γ BHC) in Stockton. The campaign was rapid and very intensive indeed, and so it was that under all these conditions the chances of reinfestation were low although the infestation level was high. (For details see K. Coates in this issue.

The second area comprised parts of Middlesbrough, where the chances of reinfestation were intermediate. The districts were less geographically isolated, increasing contact with untreated areas outside them. The trial was also made later, when the effects of publicity had worn off,

and was not as concentrated in time due to the difficulty in dealing with the larger area covered.

The area with the highest likelihood of reinfestation was Stepney in London. There was no prior local publicity. Children were drawn from a large and indeterminate area, throughout which no special antilouse activity was in progress. The chances of reinfestation were high in consequence. It should be realized, however, that the general level of efficiency in louse control in this Borough is high.

In all three types of area, resistant lice were known to be present. Samples of Teesside lice were collected and used to rear laboratory colonies, in containers on the human body. Some difficulty was experienced with these, due in part to the lice being distinctly smaller than usual, especially in the first instar, resulting in escapes through the air holes of the standard containers. It was not thought necessary to do more than a check on the Stepney lice as resistance was already known from this area (Maunder 1971).

Adult lice from the second and subsequent generations were tested using the standard Busvine-Lien body-lice resistance test at 26°C and 70% humidity. The results are given in Table II. It is convenient to use dieldrin in such tests, lice resistant to it exhibiting cross-resistance to γ BHC. DDT is not in the same resistance group and must be tested separately. The lice were resistant in both groups.

TABLE II
Mortality of lice exposed to insecticide resistance testing

Louse strain	Insecticide	Concentration	% Mortality at 24 hours
Teesside	—	Control	3 (33)
	DDT	2.0%	18 (33)
	DDT	4.0%	71 (31)
	Dieldrin	1.6%	34 (32)
	Dieldrin	4.0%	64 (33)
Camden	—	Control	Nil (10)
	Dieldrin	4.0%	60 (20)
Stepney	—	Control	Nil (10)
	Dieldrin	4.0%	50 (20)

Figures in parentheses are the total number of animals used in each test.

In the clinical trials, malathion was markedly superior in both initial kill and residual action. A summary of the results is given in Table III, which shows that up to 10.6% of BHC treatments failed to give initial control. The variation here may be due to differing proportions of resistant insects in the louse populations of the three types of area.

The reinfestation rate within 1 month rises dramatically with increased opportunities for reinfestation when BHC is used, but much less so with malathion. It is clear that a strong residual action is associated with malathion, and that this protective effect is not an artifact due to lack of opportunity for reinfestation. Studies of individual cases suggest that the residual effect is weakened if the hair is washed within approximately 12 hours after treatment. Full details of these trials are given in Table IV.

Clippings of hair from the heads of children treated with malathion between 1 and 6 weeks previously were placed

TABLE III
Percentage of children found to be lousy within 1 month of treatment (accumulative percentages)

Type of area	Time of reinspection	Insecticide used in treatment*	
		0.2% BHC	0.5% Malathion
Low reinfestation chances	1-3 days	4.2	Nil
	1 month	11.0	1.3
Moderate reinfestation chances	1-3 days	10.1	Nil
	1 month	37.0	7.4
High reinfestation area	1-3 days	10.6	Nil
	1 month	50.0	4.6

* Insecticide strengths chosen to equal those in Lorexane lotion (γ BHC) and in Prioderm lotion (malathion).

in open-bottomed metal boxes containing healthy lice from a laboratory colony. The boxes were fixed to the shaved human fore-arm with the open side against the arm, so that the lice could obtain free access to the skin for feeding. The hair clippings were lethal to the lice, the colonies dying off slowly in unvarying pattern. Only eggs laid shortly after contact with the hair were normal and viable. Later eggs became increasingly abnormal, the last ones consisting of little more than irregular masses of cement. Eventually egg-laying ceased, and of those that were laid most failed to hatch after incubation. Mating also ceased, the males having the aedeagus permanently extruded. Meanwhile, the insects found difficulty in feeding. The haustellum was continuously everted and the quantity of blood taken at each meal decreased gradually until feeding finally stopped. Despite the formation of irregular brown patches in the thoracic musculature, which were not due to rupture of the gut, locomotion was normal until shortly before death, to which inanition appeared to contribute greatly. The time to death was widely variable, the details being given in Table V. The sequence of events leading up to death form a different pattern from that seen when lice are given acute lethal doses of malathion. In such cases there is rapid and massive paralysis of locomotory musculature, a feature which did not appear when the insects acquired chronic lethal doses from the hair clippings.

Discussion

In addition to the more formal trials described, malathion was also given to parents for home use on their families, resulting in the successful treatment of 167 cases. It has also been used in several clinics in an everyday manner.

Nearly 3,000 people have been treated with 0.5% malathion lotion and no live lice have been recovered from any case on the following day. The ovicidal effect is complete and the residual effect considerable. Nurses and other users have been generally enthusiastic, although some have questioned the toxicity of the preparation, knowing malathion to be an organophosphorus compound. It is not generally realized that it is, nevertheless, in all respects, less toxic to mammals than DDT; and in any case, the

TABLE IV
Comparison of residual effects of malathion and γ BHC

Area	Reinfestation chances	Insecticide	No. treated	% with lice at 1-3 days	No. reinspected at 1 month	% with lice at 1 month (excluding those lousy at 1-3 days)	No. reinspected at 3 months	% with lice (excluding those lousy at 1-3 days and at 1 month)
Eston	Low	0.5% Malathion lotion	777	Nil	710	1.4	659	6.2
Stockton	Low	0.2% γ BHC (Lorexane)	729	4.2	680	7.2	487	4.5
Middlesbrough	Intermediate	0.5% Malathion lotion (Prioderm)	230	Nil	224	7.6	—	—
Middlesbrough	Intermediate	0.2% γ BHC	247	10.1	236	28.1	—	—
Stepney	High	0.5% Malathion lotion (Prioderm)	113	Nil	86	4.6	—	—
Stepney	High	0.2% γ BHC lotion	71	10.0	60	41.7	—	—

TABLE V
Mortality and fecundity of laboratory lice on hair clipping from children treated with malation

Hair collected, weeks after treatment	Lice Involved	No. alive, after stated hours										No. females	Eggs expected	Eggs laid	No. hatching
		6	12	18	24	30	36	42	48	54	60				
1	6	6	6	Nil	—	—	—	—	—	—	—	3	12	Nil	—
1	6	6	6	5	Nil	—	—	—	—	—	—	3	16	3	1
2	6	6	Nil	—	—	—	—	—	—	—	—	3	16	Nil	—
2	6	3	1	Nil	—	—	—	—	—	—	—	3	2	Nil	—
3	8	8	8	8	8	8	8	4	Nil	—	—	4	50	9	2
3	8	8	8	8	8	8	8	—	—	—	—	4	16	2	Nil
4	6	6	6	6	6	6	4	1	Nil	—	—	3	36	15	2
4	6	6	6	6	6	6	3	Nil	—	—	—	3	30	7	Nil
5	6	6	6	6	6	5	Nil	—	—	—	—	3	24	Nil	—
5	6	6	6	6	6	6	6	6	Nil	—	—	3	48	21	8
6	6	6	6	6	6	6	2	1	Nil	—	—	3	30	10	5
6	6	6	6	6	6	6	6	6	6	6	6 ^a	3	60	32	15
Untreated	6	6	6	6	6	6	6	6	6	6	6	3	60	57	50
Untreated	6	6	6	6	6	6	6	6	6	6	6	3	60	61	53

* Feeding greatly diminished, early death probable.

0.5% commercial lotion has been approved by the Commission for Drug Safety (that is Prioderm).

In the trials, no adverse side effects were observed, except for a slight temporary increase in dandruff in persons prone to this condition. (This effect could be due to the solvent, rather than the insecticide.) The treatment was used without harm in cases of impetigo, where it is usual to kill the lice before antibiotic treatment.

Unless every egg is combed from the hair, which is particularly difficult with recently laid ones still close to the scalp, eggs may be found which retain every appearance of life for many days after treatment. These probably are still technically alive, but as they never hatch they can be regarded for all practical purposes as dead. They retain such a fresh appearance as to mislead nurses into thinking that adult lice must still be present. In these cases walking stages have never been found.

Conversely, usually some weeks after treatment, live lice reappear on some heads, but are not accompanied by any fresh eggs. The laboratory work suggests that these are re-infestations on hair still sufficiently poisonous to prevent egg-laying. These lice are almost exclusively third instar or adult, and this suggests that transmission of walking stages from head to head is more common than transmission of eggs on stray hairs.

Malathion has the reputation of being a foul-smelling compound, due to the release of mercaptans by hydrolysis. Some smell was noticeable with preparations prepared by dilution from technical concentrates, but with the commercial malathion head louse lotion (Prioderm) used widely in these trials the characteristic offensive odour of mercaptans was absent.

Malathion does not loosen nits from the hair. Unfortunately, no substance known will do this without harm to the hair, as the eggshell appears to be constructed of protein similar to that of the hair itself.

A report from the Surgeon-General of the United States Army (*US Army Press Release*) indicates the presence in East Africa of a strain of body louse resistant to malathion. The probability is that malathion has no more than 10 or 20 years of useful life before organophosphorus resistance appears in head lice.

It is clear that DDT and BHC, once so effective, and now nearly useless, have been largely wasted. Many authorities have spent much effort and material in doing little more than contain the problem. Each authority would do well to consider a campaign on the lines of Teesside, while this new weapon is at its most potent. There are not so many more safe substances an entomologist could bring forward, and this one should be used more effectively than its predecessors. In waging war on the louse, it should be remembered that the family is all-important, especially the mothers and under-fives who,

together, constitute half (and the more difficult half) of the problem.

Considerable reservoirs of infestation can exist in "good class" areas, and no school, even a grammar school, should be exempt from occasional inspection. It can also be helpful if parents realize that it can be a criminal offence, punishable in the courts, to allow a child, once treated, to become verminous again. In this respect full use should be made of statutory powers, including occasional prosecutions in suitable cases. There are a few parents who will never learn, but for most, publicity is essential. We have the technical abilities needed to virtually exterminate the louse. What is needed now is an end to half-hearted measures.

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