SHORT REPORT

Surveillance of insecticide resistance in head lice using biochemical and molecular methods
D Rh Thomas, L McCarroll, R Roberts, P Karunaratne, C Roberts, D Casey, S Morgan, K Touhig, J Morgan, F Collins, J Hemingway


Treatment of head louse infection is primarily through topical insecticides. However, there is growing evidence of resistance. A representative population sample was tested using biochemical and molecular methods; it was shown that, in Wales, treatments containing pyrethroids are likely to be less effective in controlling head louse infection than those containing organophosphates.

Two classes of insecticides are commonly used for the treatment of head louse infections in the United Kingdom: organophosphates (malathion) and pyrethroids (permethrin and phenothrin). These formulated insecticides are available for purchase in community pharmacies, with pyrethroids the most widely used due to shorter contact time and less odour. A third class of insecticide, carbamates (carbaryl) is available in the UK on prescription only.

Insecticide resistance is often observed in insect populations where insecticides are heavily used, and resistance to pyrethroids and malathion has now been reported in UK head louse populations.1 Resistance to insecticides is conferred by a limited number of mechanisms in all species of insect analysed to date. These tend to involve either metabolic detoxification of the insecticide before it reaches its target site, or changes in sensitivity of the target site, so that it is no longer as susceptible to insecticide inhibition. In order to assist the Welsh Assembly Government in providing recommendations on the treatment and control of head louse infection in Wales, we carried out a cross-sectional survey of insecticide resistance in head lice affecting primary school children.

METHODS
A 3% random sample of schools was drawn in three of the five health authority areas in Wales from a list of 1644 local education authority run primary schools in January 2000 (total 288 387 pupils, mean 175 pupils per school). Pupils at the selected schools whose parents had given informed consent for participation were screened with detection combs on dry hair using a standard protocol.2 A case was defined by the presence of at least one living head louse. Parents of children infected with head lice were informed and all children screened for head lice. Live head lice were detected in 231 of children screened (prevalence 8.3%; 95% CI 7.3–9.4%).

Biochemical assays were carried out on 393 head lice to assess the activity of glutathione S-transferase, monooxygenases, and esterases. Glutathione S-transferase (GST) activity, associated with primary DDT resistance and secondary pyrethroid resistance, ranged from 0.17 to 3.60 nmol/min/mg (mean 0.81, median 0.69) and was higher than that previously reported in a laboratory maintained susceptible population of body lice (p < 0.001) (fig 1).3 However, microsomal monooxygenase quantity (mean 0.00083 nmol/min/mg, median 0.00048, range 0.0000364–0.0074) and total esterase activity (mean 0.00019 nmol/min/mg, median 0.00014, range 0.00001–0.00154 with α-naphthyl acetate as substrate; mean 0.00018 nmol/min/mg, median 0.00014, range 4.09e-5–0.00119 with β-naphthyl acetate as substrate), both of which are associated with organophosphate resistance, were lower than in susceptible lice (p < 0.001).

The frequency of pyrethroid resistance genes was measured in 316 lice. Fifty five of these lice (17.4%) were homozygous susceptible for pyrethroid and DDT target site sensitivity.

RESULTS
Thirty one of the thirty two (97%) schools randomly selected agreed to participate. Schools recruited to the study were representative of those in the areas of Wales studied, in terms of both size (p = 0.27) and proportion of pupils eligible for free schools meals (p = 0.12), but in relation to Wales as a whole, were smaller (p = 0.02) and had fewer children eligible for free schools meals (p = 0.02). Of 4045 children enrolled in the 31 schools recruited, 69% (2793) were screened for head lice. Live head lice were detected in 231 of children screened (prevalence 8.3%; 95% CI 7.3–9.4%).

Biochemical assays were carried out on 393 head lice to assess the activity of glutathione S-transferase, monooxygenases, and esterases. Glutathione S-transferase (GST) activity, associated with primary DDT resistance and secondary pyrethroid resistance, ranged from 0.17 to 3.60 nmol/min/mg (mean 0.81, median 0.69) and was higher than that previously reported in a laboratory maintained susceptible population of body lice (p < 0.001) (fig 1).3 However, microsomal monooxygenase quantity (mean 0.00083 nmol/min/mg, median 0.00048, range 0.0000364–0.0074) and total esterase activity (mean 0.00019 nmol/min/mg, median 0.00014, range 0.00001–0.00154 with α-naphthyl acetate as substrate; mean 0.00018 nmol/min/mg, median 0.00014, range 4.09e-5–0.00119 with β-naphthyl acetate as substrate), both of which are associated with organophosphate resistance, were lower than in susceptible lice (p < 0.001).

The frequency of pyrethroid resistance genes was measured in 316 lice. Fifty five of these lice (17.4%) were homozygous susceptible for pyrethroid and DDT target site sensitivity.

Figure 1 Glutathione S-transferase activity distribution in head lice collected from primary school children in Wales compared to an insecticide susceptible laboratory strain of body lice. Data taken from Hemingway et al.3
the findings on resistance can be applied to other parts of the United Kingdom will depend largely on local patterns of insecticide usage. It is important to note that in this study resistance was measured to the active ingredients and not the formulated product. Formulations may vary slightly by country. In the United States, for example, the formulation of malathion based insecticides differs to that in the United Kingdom, containing isopropyl alcohol, a chemical which is reported to have pediculicidal properties.7

In conclusion, we would recommend that, in Wales, products containing organophosphates, rather than pyrethroids, be used as first line treatment for head louse infection in Wales. Since carrying out this study, a new product, 4% dimeticon lotion, has become licensed for use against head louse infection in the UK, and has been shown to be as effective and safe as phenothrin.8 Where rates of resistance to pyrethroids are high, such as appears to be the case in Wales, this silicone based insecticide may be a suitable alternative. No data are yet available on the relative effectiveness of dimeticon and malathion in the management of head louse infection.

ACKNOWLEDGEMENTS
This paper is dedicated to the late Dr Fran Collins. Dr Bill Smith conceived the project. The project would not have been possible without the participation of School Nursing staff and the cooperation and support of all head teachers and staff at the schools visited. Richard Lewis and Claire Nash provided administrative support. Ethical approval to carry out the work was provided by the All Wales MREC and LREC’s in the areas participating. The study was part funded by the Wales Office of R&D for Health and Social Care.

REFERENCES
Surveillance of insecticide resistance in head lice using biochemical and molecular methods

D Rh Thomas, L McCarroll, R Roberts, et al.

Arch Dis Child 2006 91: 777-778 originally published online June 14, 2006
doi: 10.1136/adc.2005.091280

Updated information and services can be found at:
http://adc.bmj.com/content/91/9/777.full.html

These include:

References
This article cites 5 articles, 1 of which can be accessed free at:
http://adc.bmj.com/content/91/9/777.full.html#ref-list-1

Article cited in:
http://adc.bmj.com/content/91/9/777.full.html#related-urls

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections
Articles on similar topics can be found in the following collections

Dermatology (13960 articles)

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/