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# Use of sentinel lambs to survey the effect of an education programme on control of transmission of *Echinococcus granulosus* in South Powys, Wales

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*In this article the effects of an education programme (area II) on transmission of Echinococcus granulosus from dogs to sheep in Wales and of substitution of the education programme by a 6-weekly anthelmintic control programme (area I) are compared with the situation in an area where no control interventions had occurred (area III). The education programme failed to prevent transmission of E. granulosus to sentinel lambs examined at 15 months of age, 6%, 4%, and 10% of which were infected in areas I, II, and III, respectively. Educational efforts did, however, show some positive effects; for example, significantly more farmers (87–98%) in areas I, II, and III used praziquantel to treat their dogs compared with 39% of farmers in a lowland area in the east of England where E. granulosus is absent. In particular, the interval between treatments of dogs was significantly shorter in areas targeted with education programmes, and 38% of farmers in area I treated dogs at a 4–6-week interval, as did 17% in area II and 10% in area III, compared with only 3% in the lowland area. Also, more dogs in Wales (65–88%) were treated at an interval of ≤3 months, whereas most of the dogs in the lowland area (64%) were treated at intervals of ≥6 months. The shorter treatment intervals with praziquantel may account for the significantly fewer positive coproantigen tests among dogs in area I (6.3%) and area II (5.6%) compared with area III (23.9%).*

## Introduction

The South Powys Hydatidosis Control Scheme began in an area of South Powys, Wales, in April 1983. Funded by the Welsh Office, the scheme involved visits by trained personnel of the state veterinary service to farms, hunt kennels and many private houses. Data on dogs were recorded and the animals were dosed every 6 weeks with praziquantel without cost to the owners (1). In addition, veterinary services personnel instructed farmers on the life cycle of *Echinococcus granulosus* and on the need to prevent dogs from gaining access to sheep carcasses.

The control scheme monitored the level of transmission of *E. granulosus* in 1984–85, and it was demonstrated, for the first time, that treatment of dogs with praziquantel every 6 weeks for 1 year stopped transmission of *E. granulosus* to sentinel

lambs over a large geographical area (2). This occurred even in the absence of legislation to ensure owner compliance. Furthermore, between 1984 and 1989 the incidence of cystic echinococcosis in humans fell from 4.0 to 2.3 per 100 000 in the County of Powys, while the incidence remained relatively constant in most of the surrounding Welsh counties not subject to control, but increased in neighbouring Gwent (3). Particularly encouraging was the lack of cases in Powys among children aged ≤14 years, since any such cases are most likely to reflect new rather than latent, pre-existing infections. The prevalence of infection in old sheep declined by >50%, although in 1988–89, a total of 10% of inspected sheep still remained infected (3).

In 1989, farm visits and issue of free anthelmintic ceased, to be replaced by a publicity and educational campaign, directed by the Powys Health Promotion Unit and funded by the Welsh Office Health Department, and more recently by Dyfed-Powys Health Authority. Targeted were 9–11-year-old children with a video film, classroom and home exercises, and leaflets. Information was made available and distributed at agricultural events, including livestock markets, shows and dog trials, at meetings with health organizations, and in local community meetings with the public. Farmers also were encouraged by veterinary practitioners to worm their dogs.

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Change from a "fast-track", vertical programme (anthelmintic every 6 weeks) to a "slow-track", horizontal programme (education) should influence the rate of control of *E. granulosus* (4), particularly as old, infected sheep still remained in the area. Furthermore, the efficacy for control of *E. granulosus* of an education programme directed at encouraging private owners to dose their dogs and prevent them from scavenging, and without official interventions, had not been monitored previously. In 1995–96 we therefore used sentinel lambs, as described by Lloyd et al. (2), to monitor the progress of control based on an educational campaign.

## Materials and methods

Two lambs were purchased from each of 76 farms in three mountainous areas of Wales. Area I fell within the South Powys 1983–89 anthelmintic control area, where cessation of transmission had been shown previously; area II, in Powys, had not been targeted in 1983–89 but both it and area I received the publicity and educational campaign beginning in 1989; area III, in Gwent, had received neither anthelmintic nor educational interventions. The three areas are contiguous: area I is surrounded by area II to the north and to an extent to the east, and area III lies east of these other areas. Lambs were grazed on the farms of origin until they were slaughtered for human consumption at approximately 15-months of age. The livers, lungs, hearts, stomachs, intestines and omenta were examined grossly for cestodes and the livers, lungs and hearts cut into approximately 2-mm thick slices. Any suspect lesions were removed for histological processing (2).

All the dogs on each farm ( $n = 336$ ) in areas I–III were sampled 9 months into the grazing period for coproantigen analysis. Rectal faecal samples were frozen until analysed by enzyme-linked immunosorbent array (ELISA), as described by Allan et al. (5); a genus specificity of >96% and sensitivity

of 77% and 88% have been described in two studies involving natural canine echinococcosis derived from sheep (5, 6). The high specificity ensures a good predictive value, while false-negative dogs exhibit worm burdens <30.

Farmers were sent a questionnaire to determine what measures they used to control sheep diseases; the questionnaire contained also routine questions on dogs and cats and movement of sheep. In addition to the farms where the lambs had been purchased, another 75 farms in the three study areas plus 112 lowland sheep farms were selected at random and sent questionnaires. The lowland farms were mainly in the east of England, all in areas where *E. granulosus* is not endemic. About 60% of the lowland farmers had been contacted by telephone about the questionnaire.

## Results

*E. granulosus* was present in sheep on farms in all three study areas, although the numbers were too low for statistical comparison (Table 1). The other dog/sheep cestodes, *Taenia hydatigena* and *T. ovis*, also were present in roughly the same proportions as in 1985 (2).

Six of the nine farms with an *E. granulosus*-infected sheep also had 1–3 dogs that were positive for coproantigen. Coproantigen was detected in dogs in all three areas but the frequency was highest in area III ( $P < 0.0001$ ,  $\chi^2$  test) (Table 1). Also, 46% of the farms surveyed in area III had at least one positive dog, compared with 15% and 28% in areas I and II, respectively.

The response to the questionnaire was high: 70.5% among lowland farmers and 50.3% among Welsh farmers (62% in area I, 50% in area II, and 39% in area III). The effects of the educational campaign on dog treatments for cestodes are shown in Table 2. Praziquantel is the only drug licensed in the United Kingdom that is effective against *E.*

Table 1: Distribution of sheep infected with *Echinococcus granulosus*, *Taenia hydatigena*, and *T. ovis* and of dogs coproantigen positive for *E. granulosus* in the three study areas

	No. sheep infected/No. examined			No. dogs positive for coproantigen/ No. examined
	<i>E. granulosus</i>	<i>T. hydatigena</i>	<i>T. ovis</i>	
Area I : Anthelmintic + education	3/50 (6.0) <sup>a</sup>	21/50 (42.0)	7/50 (14.0)	7/112 (6.3)
Area II : Education	2/46 (4.3)	23/46 (50.0)	2/50 (4.3)	7/125 (5.6)
Area III : No interventions	5/48 (10.4)	21/48(43.8)	4/48 (6.3)	21/88 (23.9)

<sup>a</sup> Figures in parentheses are the % infected.

Table 2: Distribution of farms that reported worming their dogs, by drug and interval

	% of farms in:			
	Area I (n = 31) <sup>a</sup> (anthelmintic + education)	Area II (n = 25) <sup>a</sup> (education)	Area III (n = 20) <sup>a</sup> (no interventions)	Lowland (n = 79) <sup>a</sup> (no interventions)
<i>Drug used</i>				
Praziquantel	75.8	38.7	57.0	3.1
Praziquantel + nematocide <sup>b</sup>	21.0	48.4	41.2	35.4
Another <sup>c</sup>	3.2	12.9	1.7	61.5
<i>Treatment interval</i>				
4–6 weeks	37.5	16.7	10.0	2.9
Approx. 3 months	50.0	54.2	55.0	32.8
≥6 months	12.5	29.1	35.0	64.3

<sup>a</sup> No. of replies in area.

<sup>b</sup> Tablets contained pyrantel + febantel against nematodes and praziquantel against cestodes.

<sup>c</sup> Products effective against nematodes and/or cestodes but not containing praziquantel.

*granulosus*, and significantly more Welsh farmers (87–98%) used it either on its own or in combination with a nematocide, compared with only 39% of the lowland farmers ( $P < 0.0001$ ,  $\chi^2$  test) (Table 2). Similarly, 37.5% of farmers in area I reported anthelmintic treatment of their dogs at 4–6-week intervals, with 87.5% treating by approximately 3 months. Although the treatment intervals become longer in areas II and III, the interval between treatments was longer in the lowland area, with the majority of farmers (64.3%) treating dogs at ≥6-month intervals ( $P < 0.0001$ ) (Table 2). Movement of sheep was common in Wales, 58% of farmers in areas I–III moving unbred ewe lambs or pregnant sheep to grazing on another farm during the winter months, compared with only 18% of the lowland farmers.

## Discussion

The recrudescence of *E. granulosus* transmission in area I in South Powys demonstrated that lifting the “fast-track”, attack phase of 6-weekly treatment control (4) was premature. The attack phase of control had not reached the stage where infection in adult sheep had fallen to the very low levels that permit identification of infected farms and slaughter of infected sheep or quarantine of infected premises (4). Thus, when the educational campaign was instituted, approximately 10% of adult sheep remained infected with *E. granulosus* (3) and so were available for scavenging. This must be compounded by the considerable movement of sheep and dogs between farms in Wales.

It is disappointing that the educational campaign was unable either to prevent the return of transmission of *E. granulosus* to an area where its transmission had ceased or to prevent transmission

in area II. This may place humans, especially children, at risk. It should be noted that the educational programme was not intensive, being limited to the funds available. Similar education programmes have had variable effects, usually undocumented, in other countries. A highly effective education programme, albeit one that also included reduction in dog numbers by taxation, began in Iceland in the nineteenth century and eventually eradicated *E. granulosus* (7). In contrast, in Uruguay an education programme with limited funds and registration of infected dogs and collection of drugs from police stations failed to contain *E. granulosus* over 20 years (4). In New Zealand, an education programme that encouraged voluntary dosing of dogs with arecoline, provided free, plus improvement of abattoir facilities, did not control *E. granulosus* between 1938 and 1959 (8).

None the less, the effects of the educational campaign were apparent, particularly in area I and the contiguous areas in this study. Thus, the dog treatment interval reported by Welsh farmers was significantly lower than in the lowland area — the majority of farmers in areas I and II treated dogs at approximately 6-week or 3-month intervals. Also, the majority of farmers in Wales (>95%) used the appropriate drug, praziquantel (the only drug available in the United Kingdom for control of *E. granulosus*), compared with 39% of farmers in the lowland area — who used it primarily as a broad spectrum combination wormer. The higher use of praziquantel and the somewhat shorter treatment intervals in area III compared with the lowland area, both of which had received no interventions, probably can be accounted for by the close cooperation between farmers in areas I, II and III. However, this effect was not sufficient to reduce the prevalence of *E. granulosus* coproantigen in dogs in area III to the levels seen in areas I and II.

The effects of the previous control programme in 1983 and the education programme appear to account for the significantly lower prevalence of *E. granulosus* infection in dogs in areas I and II compared with area III. Dog treatments given at a  $\leq 3$ -month interval in areas I and II may control *E. granulosus*. The 6-weekly treatment regimen is based on the 7-week prepatent period of *E. granulosus*, but dogs do not necessarily become reinfected immediately after treatment. For example, in Uruguay, after treatment with praziquantel, dogs became reinfected with *E. granulosus* only 2–4 months later and the prevalence of infection reached pretreatment levels after 4–8 months (9). Also, in Tasmania and Otago/Southland, New Zealand, educational efforts and use of arecoline dosing up to four times a year plus quarantine (in Tasmania) controlled or reduced the prevalence of *E. granulosus* to low levels, respectively (4, 8). Therefore, an educational programme in Powys that achieves a  $\leq 3$ -month dosing interval with praziquantel, the efficacy of which is greater than that of arecoline, could achieve control, albeit over a longer period than with 6-weekly treatments. Surveillance is also needed to ascertain the public health risk, which otherwise would be detected only after several years of incubation as new cases of disease emerge among children (10).

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### Résumé

#### Utilisation de moutons sentinelles pour étudier l'effet d'un programme éducatif sur la transmission d'*Echinococcus granulosus* à South Powys, pays de Galles

Cette étude compare les effets d'un programme éducatif (secteur II) sur la transmission d'*Echinococcus granulosus* du chien au mouton dans le pays de Galles et du remplacement de ce programme par un programme d'administration d'un traitement anthelminthique toutes les 6 semaines (secteur I) à la situation observée dans un secteur

où aucun programme de lutte n'a été appliqué (secteur III). L'examen de coupes minces et l'histologie du foie et des poumons réalisés sur les moutons sentinelles à l'âge de 15 mois ont montré que le programme éducatif n'avait pas réussi à empêcher la transmission d'*E. granulosus*. Une infection a été trouvée respectivement chez 6%, 4% et 10% des moutons sentinelles nés et élevés dans les fermes des secteurs I, II et III. Les effets du programme éducatif ont été étudiés au moyen d'un questionnaire comportant, outre des questions sur les pratiques générales de l'élevage en matière de maladies ovines, des questions sur la vermifugation des chiens. Ce questionnaire a été envoyé aux élevages d'origine des moutons, à 25 autres élevages de chacun des trois secteurs de l'étude et à 112 élevages des basses terres de l'est de l'Angleterre, où *E. granulosus* est absent. Malgré la recrudescence d'*E. granulosus* dans le secteur I et la transmission de l'infection dans le secteur II, la campagne d'éducation a eu des effets démontrables. Une proportion sensiblement plus forte d'éleveurs (87–98%) utilisaient le praziquantel pour traiter leurs chiens dans les secteurs I, II et III que dans la région des basses terres (39%), où ce produit était davantage utilisé en association anthelminthique à large spectre. On a en particulier observé que l'intervalle entre deux traitements était significativement plus court dans le pays de Galles, où 38% des éleveurs du secteur I traitaient leurs chiens à intervalles de 4–6 semaines contre 10 à 17% dans les secteurs II et III et 3% dans les basses terres. La proportion de chiens traités à intervalles  $\leq 3$  mois était de 88% dans le secteur I, 71% dans le secteur II et 65% dans le secteur III, tandis que dans les basses terres la plupart des chiens (64%) recevaient les traitements à  $\geq 6$  mois d'intervalle. La brièveté des intervalles entre traitements pourrait expliquer la proportion significativement plus faible des chiens présentant un test positif de recherche de l'échinococcose canine (mise en évidence de l'antigène dans les déjections) dans les secteurs I (6,3%) et II (5,6%) que dans le secteur III (23,9%).

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