OP sheep dips – new study sheds light on an old problem

Many former sheep farmers in the UK believe their health has been permanently damaged by using organophosphate sheep dips. Now a new study confirms that even low level exposure can lead to long-term neurological damage. ***Ruth Beckmann*** *reports.*

Sheep dipping was made compulsory in the UK by the Sheep Scab order of 1976, following the re-emergence of sheep scab – a serious disease of sheep, caused by a mite – in the early 1970's[1]. The process involves plunging sheep into a deep pit of insecticide diluted in water and ensuring they remain immersed for the specified time period. Those supervising operations are exposed to fumes and frequently splashed.

The organochlorine insecticide lindane was commonly used in sheep dips at this time, although from the 1960's onwards some dips containing organophosphates (OP's) were introduced[2]. Lindane, like other organochlorines, poses a serious environmental hazard because of its persistence and potential long-term health impacts. But OP's have much higher 'acute toxicity', meaning that exposure to them is likely to result in immediate, sometimes severe, illness. And, at least for the first few years after dipping became compulsory, no protective equipment or clothing was recommended[3].

Yet as early as 1951 the government's chief chemist at the time, Professor Solly Zuckerman, warned of the potential for chronic health effects. In his report of 1951 he recommended weekly medical checks for exposed workers, training for doctors, and that containers should be labelled with the words 'Deadly Poison'[4], none of which have been acted upon to this date.

OP's act on the nervous system by inhibiting an enzyme called cholinesterase which is crucial in the transmission of nerve impulses. Symptoms of acute poisoning include headache, muscle spasms, excess salivation, nausea and diarrhoea and breathing difficulties; in severe cases loss of consciousness and death may follow. It is well established that acute poisoning by some OP's can lead to permanent neurological damage[5]. Many believe that chronic exposure – that is, repeated exposure to low doses, which by themselves do not cause poisoning – can have similar effects.

In 1984 it became compulsory to dip sheep twice annually, and in that same year lindane dips were withdrawn because of concerns about residues[6]. Use of OP dips quickly became much more widespread, but no updated guidance was issued on safe handling. The Health and Safety Executive had produced a document on OP's in 1980 (MS17), which noted that OP sheep dips containing phenol solvents could penetrate protective gear, and that splashes should be washed off immediately, particularly when handling the concentrated product[7]. Incredibly, MS17 was not distributed to farmers, doctors or vets[8].

For some time farmworkers had been reporting recurring episodes of a severe flu-like illness, following dipping and lasting for several days. The symptoms were consistent with acute OP poisoning, although 'dippers' flu' had not been formally recognised as such[9]. Some farmers also began to suffer from chronic, debilitating physical and mental symptoms, ranging from fatigue and weakness to short term memory loss and depression. The intensity of the symptoms made it harder and harder to continue working, and some were finally forced to retire. Many are certain that the OP's were responsible for their ill-health. It is not known how many farmers have been affected in this way, but the support group OPIN (Organophosphate Information Network) is in contact with some 800 farmers.

Those affected faced an uphill struggle to find either a diagnosis, or any treatment which has alleviated their symptoms. More frustrating still was the fact that no compensation – or even recognition – was forthcoming from the government which had made sheep dipping a legal requirement. The full story of their struggle is complex, but for those looking for information, the OPIN website is a good place to start: www.opin.info. Campaigners have been hampered by the difficulty in establishing cause and effect in chronic exposures of this kind. The government's stance has been guided by the Committee on Toxicity report of 1999, which concluded that the balance of evidence did not support the existence of long-term neurological effects from chronic exposure to OP's[10]. It did however acknowledge certain limitations to the research, and could not rule out the possibility that some individuals were more susceptible than others[11]. As a result of the COT report, six new government-funded studies were commissioned. One of these was to investigate further the possibility of neurological impacts from chronic exposure.

A pole is used to ensure sheep are completely immersed for the specified time

Photo: Nigel Cattlin/Holt Studios

Background to the research

One of the complexities of researching the chronic effects of OP's is that the symptoms experienced by the sheep farmers are variable, difficult to measure, and common in the general population. However, a number of studies have now demonstrated some evidence of measurable neurological impacts, such as effects on attention[12], touch perception[13] and manual dexterity[14]. The effects have generally been subtle, and other studies have found little or no difference between exposed and non-exposed groups[15]. However, almost all research has been on farmers who are still working, and thus might be expected to be less affected than those who have retired due to ill health. This 'healthy worker effect' may have been distorting research findings. One of the COT-commissioned studies, led by Sarah Mackenzie Ross, set out to correct this.

Research has also suggested that some people have a genetic difference which makes them more susceptible to OP poisoning. The enzyme paraoxonase (PON1) helps to detoxify OP's in the body and so provides some protection. PON1 exists in different subtypes which process OP's at different rates, thus conferring greater or lesser resilience to OP's. Sheep dippers with chronic ill-health have been found to be poorer metabolisers of OP's than sheep dippers with no such problems[16,17].

New study of chronic effects

The study aimed to establish whether subacute exposure to OP's is associated with neuropsychological impairments, to determine the nature and extent of these problems, and to investigate whether some individuals are more susceptible to OP's than others[18].

Led by Sarah Mackenzie Ross a team of researchers compared 132 sheep farmers with a history of low level exposure to OP's, with 79 rural policemen, who were matched

for age, gender, years in education and intelligence, but had not been exposed to OP's. In order to rule out the 'healthy worker effect' the study included both farmers and policemen who were retired. Participants were selected carefully to exclude those with a history of acute OP poisoning, or of other medical problems which might cause similar neurological impairments.

Detailed neuropsychological tests were carried out on all participants. The tests used are known to provide clinically valid information, and are routinely used in the NHS for diagnostic purposes. They measure functions such as memory, response speed, mental flexibility, and fine motor skills.

Participants were also interviewed about their exposure history and completed questionnaires on their levels of stress, anxiety and depression and physical symptoms. Finally blood tests were taken to determine their genetic subtype for PON1.

Neurological impacts

The farmers scored lower for response speed, working memory, verbal and visual memory, mental flexibility and fine motor control, than did the policemen. Statistical tests showed weak, but significant, correlations, between exposure duration and some of the cognitive impairments: in other words the more an individual had been exposed to OP's, the more likely they were to show these impairments. The statistical analysis showed that these associations were unlikely to have occurred by chance.

However, very little difference was found between active and retired members of either group, although, unsurprisingly, the retired workers reported higher levels of physical symptoms and emotional distress.

These results support the hypothesis that low-level exposure to OP's is associated with neurological impairments. However, there could be a number of other explanations. It might be that the policemen scored better on the tests than farmers because of some unidentified aspect of their lifestyle. Another possibility is that the farmers suffered from higher levels of depression (mood disorders can lead to poor performance on this type of test). Alternatively, although farmers with a history of acute poisoning requiring medical attention had been excluded from the study, it was possible that some of the farmers – those who had experienced 'dippers flu' had in fact suffered from acute poisoning, although this had never been diagnosed. In order to address these alternative explanations the study results were re-analysed in three ways:

- test results were compared with a published standard set of test results obtained from a healthy cross section of the general population
- statistical analysis was done to take into account the likely effects of mood disorders on test scores
- results were re-analysed excluding any farmers with a history of 'dippers' flu'

None of these further analyses materially altered the findings of the study.

Conclusions and implications

The researchers acknowledge some limitations to the study, for example, OP exposure was estimated based on farmers' recall. For any group of people such an assessment may be prone to inaccuracies, but especially in a group suffering from memory problems. Nevertheless the methodology was very thorough in ruling out alternative interpretations of the findings, and thus offers robust evidence that chronic, low-level exposure to OP's is associated with irreversible neurological changes.

The perhaps surprising aspect of the results is that there were no differences in test results between those farmers who were still working, and those who had retired on health grounds. Thus, from this particular study, it cannot be concluded that farmers who have retired on health grounds are more at risk of harmful neurological impacts from OP's. However it must be recognised that the decision to retire is a very personal and complex one, and there may be multiple factors which enable some farmers to continue working – perhaps finding new ways around tasks they can no longer perform – whilst others can no longer do so. There was no analysis of the relationship between OP exposure and physical symptoms as this was beyond the scope of the study.

The blood tests did not reveal any differences in PON1 status between working and retired farmers, and so provided no evidence of a susceptible sub-group. However the blood test results were surprising in that no 'poor metabolisers' were seen. The researchers suggest that the study's selection procedures, such as excluding those with a history of acute OP poisoning, also ruled out those who were poor metabolisers of OP's making it difficult to draw conclusions from this aspect of the study.

The researchers point out that these results have implications for working practices, and recommend a review of policies and guidelines on use of OP's. Sheep dip products containing a pyrethroid pesticide as the active ingredient, rather than an OP, are available, and dipping is no longer compulsory (spot treatments are often used instead). However, the OP diazinon, is still used in sheep dips, so these findings are highly relevant to sheep farmers, vets and doctors today. Many others are also occupationally exposed as OP's have a wide variety of uses in agriculture. As yet Defra has made no formal response to the study.

The results are also significant for those who have claimed, for many years, that use of OP sheep dips has left them with permanent disability. For these farmers, the study confirms what they have long known: that even small doses of OP's can have serious consequences. It could be pointed out (correctly) that this study does not prove that the impairments observed were caused by OP's. Such proof is virtually unattainable, short of experimenting directly on humans. There is a pressing ethical question around how much proof is required before a government should act to prevent potential harm.

The six studies commissioned by the COT are all now complete or nearing completion, and it is expected that the COT will reconvene to review the new findings. Sheep farmers and their families and supporters will be hoping that this new study will help tip the balance in their favour. Some of those affected are still hoping eventually to gain compensation, but most agree that, above all, they are simply seeking recognition of what has happened to them – and perhaps even an apology. **(RB)**

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