EDITORIAL

Suicide by intentional ingestion of pesticides: a continuing tragedy in developing countries

David Gunnell and Michael Eddleston

Deliberate self-poisoning has become an increasingly common response to emotional distress in young adults, and it is now one of the most frequent reasons for emergency hospital admission. In industrialized countries, the drugs that people commonly take in overdose—analgesics, tranquillisers, antidepressants—are relatively non-toxic. The estimated case fatality for overdose in England, for example, is around 0.5%. Most individuals who overdose do not intend to die. Studies carried out in industrialized countries have found that only 2% go on to commit suicide in the subsequent 12 months.

In developing countries the situation is quite different. The substances most commonly used for self-poisoning are agricultural pesticides. Overall case fatality ranges from 10% to 20%. For this reason, deaths from pesticide poisoning make a major contribution to patterns of suicide in developing nations, particularly in rural areas. In rural China, for example, pesticides account for over 60% of suicides. Similarly high proportions of suicides are due to pesticides in rural areas of Sri Lanka (71%), Trinidad (68%), and Malaysia (>90%). There is, however, no evidence that levels of suicidal intent associated with pesticide ingestion in these countries are any higher than those associated with drug overdose in industrialized countries, where the drugs taken in overdose are less toxic.

Patterns of suicide in countries where pesticide poisoning is commonplace

In countries where the use of pesticides for self-harm is commonplace, pesticide poisoning is prominent in rural localities. Part of the distinct age- and gender-patterns of suicide appear to be distorted. In industrialized nations, suicide rates are two to three times higher in men than women, and its incidence tends to increase with age, although in some countries recent rises in young male suicides have distorted this pattern. The incidence of non-fatal self-harm in industrialized countries is 20+ times higher than that of suicide; in contrast to suicide, self-harm rates peak in 15–24 year olds and are generally highest in women (Figure 1a).

A possible explanation for these differences in the age- and sex-patterning of fatal and non-fatal self-harm is that young people, particularly females, are more likely to engage in impulsive acts of self-harm—as indicated by the comparatively lower levels of suicidal intent in young people. Because these acts are unplanned, the methods used are those that are readily available at the time of acute distress—prescribed and non-prescribed medicines—and these are relatively non-toxic. If more lethal methods of self-harm, such as pesticides, were favoured and readily accessible in industrialized nations, the epidemiology of suicide in these countries might be quite different. Thus the widespread availability of pesticides may contribute to the difference in the age- and sex-patterning of suicide in China, Sri Lanka, India, and several other developing countries compared with that commonly seen in industrialized nations (Figure 2). In these developing countries some of the highest rates are seen in young adults and the ratio of male:female suicide approaches or exceeds unity at this age.

In China, whilst suicide rates do tend to increase with age, there is a notable peak in rates amongst males and females aged 20–24 (Figure 2); recent data show that this peak is more prominent in rural localities. In rural India rates of suicide in 15–24 year old females are higher than rates in males of the same age and most other female age groups. Similar patterns are seen in Sri Lanka (Figure 2). In both China and Sri Lanka pesticides are the most frequently used method of suicide, likewise in India self-poisoning is the commonest method and pesticides are the most frequently used agents. It is of note that the age- and sex-patterns of self-poisoning in Sri Lanka in the younger age groups are similar to those in industrialized countries. (Figure 1b) although in contrast, the case fatality in Sri Lanka is much higher.

Part of the distinct age- and gender-patterns of suicide deaths in the developing world may therefore reflect a mixture of deaths with high suicidal intent (predominantly in the elderly) and an excess of deaths with low suicidal intent amongst the young where the method chosen for impulsive acts of self-harm (pesticide ingestion) is highly lethal. A possibility strikingly born out in Western Samoa in the 1980s, where two-thirds of all suicides were a result of pesticide ingestion and the age- and sex-patterning of suicide and non-fatal self-harm were almost identical.

Method availability and suicide

The common use of pesticides for self-harm in part reflects their ease of availability. Whilst their use in agriculture is widespread
in industrialized countries, large-scale farming is practised by a small number of landowners, thus reducing the number of people with direct access to pesticides. In contrast, most people living in rural regions of developing countries are involved in agriculture and farm small areas of land. Subsistence farmers keep their own supply of pesticides, commonly within, or close to, the household. A recent study in China found that 65% of pesticide suicides used chemicals stored in the home. 

There is general consensus that the ease of availability of particularly lethal means of self-harm may influence patterns of suicide. Suicidal impulses are often short lived and if time can be ‘bought’ allowing such impulses to pass—by making the means of suicide less readily available—a proportion of suicides will be prevented. The best documented evidence of this was the effect of the detoxification of the domestic gas supply in Britain in the 1960s—this was thought to have contributed to the prevention of an estimated 6700 suicides. Similarly, temporal and geographical variations in the availability of other commonly used methods have influenced patterns of suicide in Australia (barbiturates), USA (firearms) and Britain (catalytic converters for car exhaust fumes).

This evidence has prompted the inclusion of policies aimed at reducing access to, or the lethality of, commonly used methods within national and international suicide prevention strategies. In Britain attention has focused on restricting the availability of paracetamol (acetaminophen) and in the USA there are similar concerns about the ease of availability of firearms. The number of deaths caused by pesticides make Western concerns about these two methods of suicide appear somewhat trivial. For example, in Britain where paracetamol suicide is comparatively common, there are only around 200 paracetamol suicides per year (0.4% of all suicides). If a similar proportion of suicides were due to paracetamol worldwide (an overestimate) then using the WHO’s current estimate of 849 000 suicides worldwide each year a maximum of 34 000 of these might be attributable to paracetamol.

In contrast, the WHO estimated in 1990 that there are around 3 million hospital admissions for pesticide poisoning each year,
Figure 2. Age and sex patterns of suicide. a. In China (Source: WHO), b. Sri Lanka (Source: WHO), and c. Kaniyambadi region, S. India (Source: Joseph et al.20)
2 million of which are as a result of deliberate ingestion, and these result in around 220 000 deaths. The size of the problem is probably larger now—there have, for example, been well-recognized increases in pesticide poisonings in South Asia.21

The best evidence for estimating the global burden of suicide deaths from pesticide ingestion comes from China and South East Asia. In 2001 there were an estimated 517 000 suicides in developing countries in these regions27 and research evidence (see above) suggests pesticide ingestion accounts for over 60% of these suicides. We therefore estimate there are around 300 000 pesticide suicides each year in these regions alone. As pesticide suicides from other developing nations in Africa and South America are not included in this figure the global toll is likely to be higher.

Economics of pesticide poisoning
Deaths from pesticide ingestion are a major contributor to the global burden of suicide and premature mortality. This burden is increased by the economic and indirect health care effects of self-harm following ingestion of pesticides. Such effects have been less well documented in the research literature.

The hospital management of pesticide poisoning often requires intensive care, in particular ventilation. In 1995–1996, in one general hospital in Sri Lanka, 41% of bed occupancy on medical intensive care beds was for the treatment of pesticide poisoning. This not only drains limited healthcare budgets but also prevents the treatment of other patients requiring intensive care. Furthermore, the loss through premature death, of young, economically active, community members and the impact of their death on others (spouses, children, friends, and family) may influence productivity in communities that are on the margins of subsistence.

The costs of self-harm should be balanced against the agricultural benefits of pesticides. These have not been formally quantified and work over the last 20 years with integrated pest management has shown that reduced use of pesticides can be compatible with at least stable levels of crop production.39,40

Pesticides are also used to control disease vectors (e.g. mosquito vectors of dengue and malaria) but supplies of pesticides used for this purpose are kept in official store rooms and are therefore less likely to be available for acts of self-harm.

Any analysis of the competing adverse and beneficial effects of pesticides should incorporate the possibility of replacing pesticides which are toxic to humans with less toxic, but equally effective alternatives. Likewise the short-term effects on crop yields should be balanced against wider effects on the environment, development of parasite resistance, and possible longer-term effects of pesticide exposure on human health.

How can the death toll from pesticide poisoning be reduced?
Possible approaches to reducing deaths from pesticide ingestion are outlined in the Table. The importance of broad-based commitment from industry as well as Non-Governmental Organizations (NGO), and national and international health and regulatory organizations is highlighted.

The first broad approach is to restrict the availability of pesticides either directly, for example through restricting the import and use of pesticides, or indirectly through ensuring supplies are kept in a secure facility in each geographical locality. Restricting availability could be achieved by either direct control of particular pesticides (banning, requiring licences for use or prescriptions) or through the promotion of practices that minimize their use. Such health protection approaches appear to have led to a reduction in serious paracetamol poisonings in England35 and a decline in barbiturate suicides in Australia.37

The WHO has encouraged countries to restrict the availability of more lethal pesticides32 and countries such as Sri Lanka have followed this approach.41 In Jordan, a steady rise in fatal pesticide poisonings was reversed by increased awareness of the problem, decreased imports of some toxic pesticides, and bans on the imports of others.42 Similar effects have been observed in Western Samoa after reduced use of paraquat and a campaign to raise awareness of suicide; however, here fluctuations in imports were driven by the nation’s financial problems rather than a concern with suicide.22

The second approach is to improve public education regarding the dangers of pesticide poisoning and the safekeeping of pesticides—through media campaigns and clear labelling of product containers. The effects are difficult to predict and there is a suggestion that enhanced knowledge concerning the toxicity of pesticides resulted in an increase in their use for self-harm in some settings.12 Furthermore, it is widely recognized that media portrayal of acts of self-harm can lead to increases in ‘copy-cat’ suicides.43

The third general approach is to encourage manufacturers to improve the safety of their products. This may be achieved by diluting the concentrations of liquid pesticides, incorporating emetics or agents to make them unpleasant to taste or, more fundamentally, to produce pesticides which are non-toxic to humans.44

Company responsibility for the safe use of pesticides should extend for the entire life cycle of their use.

Lastly, if the occurrence and lethality of pesticide ingestions cannot be prevented then improved medical management is crucial.12 The lethality of pesticide poisoning is for the most part due to the difficulty of treatment and their greater toxicity compared with substances taken in overdose in industrialized countries. Antidotes to pesticides are not completely effective. In rural areas, where the majority of cases occur, health care is often distant and of poor ‘quality’. In the UK, where paracetamol is the most common poison used for self-harm, a similar situation could be envisaged if all the antidotes became unavailable—the medical wards might once again become filled with paracetamol-poisoned patients with either anticipated or florid liver failure.

Why has there been a failure to act?
The problem of death from pesticide self-poisoning is neither new12,43–48 nor unique to a few countries, so reasons for the lack of a global response need to be understood if this continuing tragedy is to be reversed.

Five main factors appear to contribute. First, the pattern of agriculture practised in developing countries—where most people living in rural areas cultivate small areas of land—is quite different from that in industrialized nations where a small number of farmers cultivate large tracts of land. In industrialized countries access to pesticides is therefore largely restricted to the few individuals engaged in farming. In developing nations pesticides are available within most peoples’ place of residence.
<table>
<thead>
<tr>
<th>Possible strategy</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Who should be responsible for action?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reduce availability of highly toxic pesticides</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduce a ‘minimum pesticides list’[^6] restricting pesticide use to a few, less</td>
<td>Reduced case fatality</td>
<td>Industry pressure against restriction from companies whose products are regulated</td>
<td>WHO/FAO</td>
</tr>
<tr>
<td>dangerous pesticides</td>
<td></td>
<td></td>
<td>National regulatory authorities/</td>
</tr>
<tr>
<td>Prohibit sales of the pesticides most lethal to humans after ingestion</td>
<td>Reduced case fatality</td>
<td>Replacement pesticides may be less effective agriculturally</td>
<td>National Government</td>
</tr>
<tr>
<td>Subsidize or reduce the costs of pesticides which are less toxic to humans</td>
<td>Reduced case fatality</td>
<td>Reduced industry profits. Costs to national Governments. Costs to industry</td>
<td>Industry.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May increase pesticide use</td>
<td>National Government</td>
</tr>
<tr>
<td>Ensure all pesticides are kept in a locked cabinet with the key held by the</td>
<td>Limited availability in times of acute emotional crisis</td>
<td>Inconvenience. Costs, difficulty policing legislation</td>
<td>National Government (legislation).</td>
</tr>
<tr>
<td>licensed user</td>
<td></td>
<td></td>
<td>Purchaser of pesticide</td>
</tr>
<tr>
<td>Appoint a village elder, schoolteacher, police officer or councillor to hold</td>
<td>Limited availability at times of emotional crisis</td>
<td>Inconvenience. Administration costs. Diminished access for farmers</td>
<td>National Government (legislation).</td>
</tr>
<tr>
<td>the locality’s stocks of pesticides centrally</td>
<td></td>
<td></td>
<td>Local Government/community</td>
</tr>
<tr>
<td>Reduce the use of pesticides in agricultural practice (e.g. Integrated Pest</td>
<td>Less pesticides around at times of emotional crisis</td>
<td>Reduced industry profit. Possibly reduced agricultural yield—further studies are required</td>
<td>United Nations.</td>
</tr>
<tr>
<td>Management [IPM])[^3,^9]</td>
<td></td>
<td></td>
<td>National Government</td>
</tr>
<tr>
<td>Ensure all remaining pesticides are returned to vendor after application</td>
<td>Limited availability in times of emotional crisis</td>
<td>Administration costs. Costs to farmers</td>
<td>Local Government/community</td>
</tr>
<tr>
<td><strong>Reduce use of pesticides in acts of self harm</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public education campaigns regarding the dangers of pesticide ingestion[^2,^4]</td>
<td>May lead to reduced quantities of pesticides being taken in self harm</td>
<td>May, by highlighting lethal dose and potential for using this method, lead to increases in suicides.</td>
<td>National and Local Government</td>
</tr>
<tr>
<td></td>
<td>May lead to more rapid help seeking from those who have ingested pesticides,</td>
<td>There is already widespread awareness regarding the dangers/toxicity of pesticides. No clear evidence of effect in Western Samoa[^2]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>as well as their friends and relatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Better labelling of products with advice regarding dangers, need for safe-keeping</td>
<td>Limited availability. Reduced case fatality because of early help-seeking and</td>
<td></td>
<td>Industry.</td>
</tr>
<tr>
<td>need for early treatment</td>
<td></td>
<td></td>
<td>National and Local Government</td>
</tr>
<tr>
<td><strong>Reduce the toxicity of pesticides taken in overdose</strong></td>
<td>Possibly reduced case fatality</td>
<td>Costs to industry. Possibly reduced agricultural effectiveness of the pesticide.</td>
<td>Industry.</td>
</tr>
<tr>
<td>Addition of emetic/antidote to all pesticide products</td>
<td></td>
<td>No consistent evidence of effectiveness[^4]</td>
<td>National regulatory bodies</td>
</tr>
<tr>
<td>Change formulation of pesticides: reduced concentration or addition of agents</td>
<td>Reduced case fatality</td>
<td>Costs to industry</td>
<td>Industry</td>
</tr>
<tr>
<td>that make them unpleasant to taste/smell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry research to produce agents which are non-toxic to humans</td>
<td>Reduced case fatality</td>
<td>Costs to industry</td>
<td>Industry</td>
</tr>
<tr>
<td><strong>Improved management of pesticide poisoning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ensure all villages have first aid kits for the immediate management of pesticide</td>
<td>Possibly reduced poison absorption and therefore case fatality</td>
<td>Costs of ensuring supplies regularly updated No evidence of effectiveness</td>
<td>National and Local Government</td>
</tr>
<tr>
<td>poisoning—charcoal; possibly emetics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve speed of transfer to hospital</td>
<td>Ensure patient is in a hospital when deterioration occurs</td>
<td>Costs to cash restricted health services</td>
<td>National and Local Government</td>
</tr>
<tr>
<td>Ensure all hospitals have adequate supplies of antidotes</td>
<td>Reduce requirements for transfer, reduce case fatality</td>
<td>Costs to cash restricted health services</td>
<td>National and Local Government</td>
</tr>
<tr>
<td>Perform research to establish best management guidelines and determine</td>
<td>Establishment of agreed best practice</td>
<td>Research costs</td>
<td>Major research funding bodies</td>
</tr>
<tr>
<td>effectiveness of antidotes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promulgate management guidelines</td>
<td>Reduced case fatality</td>
<td>Costs of synthesizing evidence to produce such guidelines</td>
<td>Major research funding bodies</td>
</tr>
</tbody>
</table>

[^6]: Reduced case fatality
[^3]: Less pesticides around at times of emotional crisis
[^9]: Reduced case fatality
[^2]: May lead to reduced quantities of pesticides being taken in self harm
[^4]: Possibly reduced agricultural effectiveness of the pesticide. No consistent evidence of effectiveness
[^2]: May lead to more rapid help seeking from those who have ingested pesticides, as well as their friends and relatives
[^2]: There is already widespread awareness regarding the dangers/toxicity of pesticides. No clear evidence of effect in Western Samoa
[^2]: Limited availability. Reduced case fatality because of early help-seeking and treatment
[^4]: Possibly reduced agricultural effectiveness of the pesticide. No consistent evidence of effectiveness
[^3]: Reduced case fatality
[^2]: Reduced case fatality
Interventions to limit access in such settings are complex and need to involve most rural adults, rather than a select few.

Second, the sale of pesticides is a multi-billion dollar business. In all, 1.5 million tons of pesticides are sold annually and sales are worth an estimated US$30 billion. Tensions commonly exist between commercial interests and population health, furthermore industry has not always acknowledged the impact of the easy availability of lethal suicide methods on patterns of suicide. In describing Western Samoa's preventive considerations following the epidemic rise in pesticide suicides in that country Bowles noted:

There was at that time a contentious debate about actually banning paraquat [(the pesticide)] entirely. We knew however that there were powerful and influential people who had a vested interest in continuing the importation and we did not want to be aligned with a lobby group likely to fail.

Third, the issue of pesticide self-poisoning has never been taken up as a campaign issue by any of the international organizations. The WHO is the pre-eminent public health organization and its Department of Mental Health and Substance Dependence (MNH) is responsible for suicide prevention. It has managed to successfully draw mental health up the worldwide political agenda over the last 10 years. It has also emphasized the global health importance of suicide, organizing workshops across the world to discuss strategies for reducing self-harm, but it has not taken up pesticides as a central issue. Recent WHO publications with major input from the MNH have put greater emphasis on psychiatric and social models of self-harm aetiology. While pesticide self-poisoning was mentioned in both reports, it received much less attention than its importance warrants.

The International Programme on Chemical Safety (IPCS) is the major WHO programme dealing with pesticides. It was set up in 1980 by the United Nations Environment Programme, the International Labour Organisation, and the WHO, to establish the scientific basis for safe use of chemicals and to strengthen national capabilities for chemical safety. Current IPCS activities aim to increase knowledge of the epidemiology of pesticide poisoning and to encourage the setting up of poisoning information centres. The IPCS has not, however, actively taken up the issue of intentional pesticide self-poisoning, concentrating instead on occupational and environmental poisoning. This is unfortunate since its own studies have indicated the great importance of self-poisoning in the Asia Pacific region.

The interests of its parent organizations may be the reason for this lack of advocacy for the problem of intentional poisoning.

Fourth, the self-inflicted nature of suicide, together with the fact there are fewer suicide deaths than deaths from other global health problems such as human immunodeficiency virus (HIV)/AIDS, tuberculosis, and malaria, may have lead to policy makers giving it lower priority than the number of premature deaths warrant.

Fifth, pesticide self-poisoning is ideologically and politically inconvenient. Pesticide use has adverse effects on the environment and human health. This has become a major global political issue. Many of the adverse effects of pesticides are considered to result from their overuse and poor treatment of workers and communities due to globalization—in which pesticide corporations are major participants. The issue has been taken up by numerous national and international non-governmental organizations (NGO), in continual ‘battle’ with the pesticide companies. In this battle, the fact that the vast majority of severe and fatal pesticide cases are self-inflicted may be inconvenient to the environmentalists. If the pesticide industry can argue that they should not be held responsible for people who drink pesticides, then this may be seen as undermining the environmentalists’ case. People therefore want to avoid the issue of self-poisoning and deal with issues where the pesticide industry, and globalization in general, can be held responsible.

This need not be true. An overall assessment of public health, environmental and agricultural factors should determine regulatory actions, not simply their political appropriateness. Pesticide self-harm is just as important as occupational poisoning for regulatory issues and, in some countries, regulatory authorities have been very effective in banning the pesticides that have been problems only for self-harm.

Conclusion

Pesticide self-poisoning is a major contributor to population patterns of morbidity and mortality in developing nations. The use of pesticides for self-poisoning may distort conventional epidemiological features of suicide in these countries and contribute to their excess premature mortality. We estimate there are around 300 000 self-inflicted pesticide deaths worldwide each year. Research dating back over 30 years has documented the size of this problem and yet contemporary research bears witness to its continuing impact.

Research to identify the most acceptable means of restricting the availability of pesticides within rural communities is urgently required together with randomized controlled trials to determine the best means of treatment and cost-effectiveness of possible interventions. Some of this research is now underway (M Edelstone, unpublished). Preventive measures must take account of the local needs and context and should be rigorously evaluated.

Thus far there has been no global leadership to respond to the problem. Engagement of national governments and leadership of the WHO, in particular the MNH and IPCS sections, on the issue is essential. Commitment from industry and the need for them to acknowledge their responsibility for some of these deaths is vital (Table), as is the need to ensure they understand the scale, importance, and preventability of the problem. Reducing the number of pesticide deaths by 50% could rapidly reduce the number of suicides worldwide by 150 000. This is quite possible.

Acknowledgements

We thank Shah Ebrahim, John Haines, Flemming Konradsen, and Mark van Ommeren for helpful comments and suggestions and Nicos Middleton, Davidson Ho, and Sanjay Kinra for obtaining some of the suicide statistics. Hospital Episodes Statistics (HES) data were made available by the Department of Health to the authors courtesy of the HES National Service Framework project (Prof. Shah Ebrahim and colleagues), funded by a South and West Regional project R & D grant. The Medical Research Council (MRC) Health Systems Resource Centre are data custodians and also fund some of the support costs. The Department of Social Medicine is the lead Centre of the MRC Health Services Research Collaboration. ME is a Wellcome Trust Career Development Fellow in Tropical Clinical Pharmacology, funded by grant GR063560MA.
References


