Preventing deaths from self-poisoning in the developing world

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South Asian Clinical Toxicology Research Collaboration, Sri Lanka
ICU occupation by diagnosis, Anuradhapura, 1995-6
Why is this important?

www.worldmapper.org
Global burden of fatal intentional self-harm

www.worldmapper.org
Pesticide self-poisoning

Major clinical problem in rural Asia

Responsible for about 60% of Asian suicides
~250-350,000 deaths every year

Incidence
~350/100,000 per year

Medical management is difficult - 10-20% case fatality if patient survives to reach hospital
Deaths from pesticide self-poisoning

High number is not due to high rates of self-harm since the rates in rural Asia are similar to rates in Western countries

Due to high case fatality: 10-20% vs <0.5%

Main risk factors are:
Toxicity of available poisons and ease of access
Case histories of pesticide poisonings

A 15 year old girl drank 20% paraquat after an argument and fight with her 11 year old brother… in her distress she had simply grabbed the nearest bottle in the house and drunk it. She died from cardio-respiratory arrest 2 days after admission.

An 18 year old woman committed suicide by swallowing a weedicide following a dispute over a wrist watch with her older sister

Van der Hoek et al 1998; Eddleston and Phillips 2004
### Case fatality
(% of deaths amongst those taking an overdose)

- **Paraquat** 70%
- **Aluminium phosphide** 60-70%
- **Organophosphate pesticides (variable)**
  - Monocrotofos 35%
  - Parathion 25%
  - Dimethoate 23%
  - Chlorpyrifos 8%
- **Yellow Oleander** 5%
- **Paracetamol** <0.5%

Sources: Ganeshamoorthy 1985; Siwach 1988; Eddleston 2005; Rao 2005; Gunnell 1997
<table>
<thead>
<tr>
<th>Commonest form of self-poisoning</th>
<th>No. hospital admissions per year</th>
<th>No. deaths per year</th>
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<tbody>
<tr>
<td>UK</td>
<td>Paracetamol</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Pesticides</td>
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<td>2,000</td>
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Gunnell *et al* 1996; Roberts *et al* 2003
What is the incidence of fatal pesticide self-poisoning?
Global estimate of pesticide suicides

<table>
<thead>
<tr>
<th>WHO region</th>
<th>Total Suicides (1,000s)</th>
</tr>
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<tbody>
<tr>
<td>Africa</td>
<td>34</td>
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<td>63</td>
</tr>
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<td>34</td>
</tr>
<tr>
<td>Europe</td>
<td>163</td>
</tr>
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## Global estimate of pesticide suicides

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<tbody>
<tr>
<td>Africa</td>
<td>34</td>
<td>8 (23%)</td>
</tr>
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<td>Americas</td>
<td>63</td>
<td>3 (5%)</td>
</tr>
<tr>
<td>E Mediterranean</td>
<td>34</td>
<td>6 (17%)</td>
</tr>
<tr>
<td>Europe</td>
<td>163</td>
<td>6 (4%)</td>
</tr>
<tr>
<td>SE Asia</td>
<td>246</td>
<td>51 (21%)</td>
</tr>
<tr>
<td>W Pacific</td>
<td>331</td>
<td>185 (56%)</td>
</tr>
<tr>
<td><strong>WORLD TOTAL</strong></td>
<td><strong>873</strong></td>
<td><strong>258 (30%)</strong></td>
</tr>
</tbody>
</table>

(Plausible range 234 - 326)
### Suicide in India

<table>
<thead>
<tr>
<th>Author</th>
<th>Setting</th>
<th>Estimated suicide rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Official rate (2005)</td>
<td></td>
<td>10 per 100,000</td>
</tr>
<tr>
<td>Banerjee <em>et al</em> 1990</td>
<td>West Bengal</td>
<td>43 per 100,000</td>
</tr>
<tr>
<td>Shukla <em>et al</em> 1990</td>
<td>Jhansi City, Uttar Pradesh</td>
<td>29 per 100,000</td>
</tr>
<tr>
<td>Joseph <em>et al</em> 2003</td>
<td>Kaniyambadi, Tamil Nadu</td>
<td>95 per 100,000</td>
</tr>
<tr>
<td>Gajalakshmi <em>et al</em> 2007</td>
<td>Villapuram, Tamil Nadu</td>
<td>62 per 100,000</td>
</tr>
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Global estimate of pesticide suicides: applying correction to India’s estimates

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<td>163</td>
<td>6 (4%)</td>
</tr>
<tr>
<td><strong>SE Asia</strong></td>
<td><strong>517</strong></td>
<td><strong>155 (32%)</strong></td>
</tr>
<tr>
<td>W Pacific</td>
<td>331</td>
<td>185 (56%)</td>
</tr>
<tr>
<td><strong>WORLD TOTAL</strong></td>
<td><strong>1,142</strong></td>
<td><strong>372 (30%)</strong></td>
</tr>
</tbody>
</table>
Clustering of self-poisoning in Sri Lanka

Celie Manuel
Flemming Konradsen
Self-poisoning in rural Sri Lanka: small area variations in incidence
Suicide rates in Sri Lanka 1880-2005

Suicide rates in Sri Lanka 1880-2005

- All class I pesticides banned 1995
- Parathion / methyl parathion banned 1984
- Endosulfan banned 1998

National number of admissions for total poisoning and pesticide poisoning, Sri Lanka 1986-2000

Agricultural yield in South Asian countries between 1980 - 2005

Cereals

Year

kg/hectare


Bangladesh
India
Pakistan
Sri Lanka

Pulses

Roots & tubers

Manuweera G et al 2008
What should be the next regulatory move?

There is marked variation in human toxicity of the different OPs, despite few differences in their agricultural efficacy.

Could we remove the two common highly toxic OPs from use?
Study design

- Study initiated by the Sri Lankan Government’s Pesticide Registrar
- Dimethoate and fenthion banned in Polonnaruwa district but not in the neighbouring Anuradhapura district in June 2003
- **Outcome** - relative change in case fatality from pesticide poisoning in the 2 district hospitals
Strengths and Limitations of this Study Design

Strengths

- Study had a control area in which the intervention was not implemented
- Prospective data collection, with identification of the ingested pesticide, from the main referral hospitals covering both districts
- Large populations under study
- Government support with active enforcement by visiting shops

Limitations

- Only one intervention area and one control area; limited no of events
- Choice of study area for intervention was not random - Polonnaruwa had the better agricultural outreach services to enforce a ban
- Ban was only implemented in 75% of Polonnaruwa district
- Impossible to stop small scale importation of dimethoate and fenthion from surrounding districts where they were still available - study contamination
Results

1. Dimethoate and fenthion patients as a % of all pesticide admissions
Results

2. Primary outcome - *Pesticide Case Fatality*

<table>
<thead>
<tr>
<th></th>
<th>Jul02-Jun03</th>
<th>Jul04-Jun06</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anuradhapura (control)</td>
<td>66/583</td>
<td>213/2003</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>(11.3%)</td>
<td>(10.6%)</td>
<td>(95% CI 0.70-1.25)</td>
</tr>
<tr>
<td>Polonnaruwa (intervention)</td>
<td>50/348</td>
<td>106/1182</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>(14.4%)</td>
<td>(9.0%)</td>
<td>(95% CI 0.41-0.84)</td>
</tr>
</tbody>
</table>

Comparison of the two centres:  P=0.051

(Mantel-Haenszel test of heterogeneity. Note the limitations of the study)
Place of death for poisoned patients

<table>
<thead>
<tr>
<th>Place of Death</th>
<th>OP</th>
<th>Carbamate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>3.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Rural Hospital</td>
<td>9.0</td>
<td>42.5</td>
</tr>
<tr>
<td>During transfer</td>
<td>5.5</td>
<td>15.0</td>
</tr>
<tr>
<td>District Hospital</td>
<td>79.5</td>
<td>32.5</td>
</tr>
<tr>
<td>After transfer to specialist hospital</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Unknown</td>
<td>2.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Checked hospitals surrounding Polonnaruwa for an increase in deaths from pesticides after the ban. We found no significant increase that might account for the reduced number of deaths in the district hospital.
3. Case fatality by quarter in the two hospitals

![Graph showing hospital case fatality by quarter from 2Q02 to 2Q06. The graph compares Polonnaruwa and Anuradhapura hospitals during the baseline 1yr and post-intervention 2yrs periods. The x-axis represents the quarters from 2Q02 to 2Q06, and the y-axis represents hospital case fatality from 0.0 to 17.5. The graph indicates fluctuations in case fatality across the periods with variations between the two hospitals.]
Results


Due to the marked difference between 2004-5 and 2005-6, we continued collecting data for another year to determine whether the effect was sustained.

<table>
<thead>
<tr>
<th></th>
<th>Pesticide cases</th>
<th>Pesticide deaths</th>
<th>Paraquat deaths</th>
<th>Carbamate deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anuradhapura</td>
<td>1038</td>
<td>78 (7.5%)</td>
<td>19 (24%)</td>
<td>5 (6.4%)</td>
</tr>
<tr>
<td>Polonnaruwa</td>
<td>569</td>
<td>69 (12.1%)</td>
<td>19 (28%)</td>
<td>12 (17.4%)</td>
</tr>
</tbody>
</table>

The marked increase in case fatality was mostly due to an increase in the number of carbamate (and paraquat) deaths in Polonnaruwa.
Conclusions

- It is possible, although difficult, to do large-scale, controlled interventional studies of public health interventions in the rural developing world.

- Banning highly toxic pesticides will reduce the case fatality from pesticide in local hospitals.

- However, this effect may be short lasting as agricultural practice shifts to other toxic pesticides (in this case a shift from OP to carbamate).

- An effective public health and regulatory approach to pesticide poisoning might consider replacing all pesticides toxic to humans with newer less toxic pesticides.
THE UTILIZATION OF PESTICIDE SAFE STORAGE DEVICES IN RURAL SRI LANKA: A LONG-TERM ASSESSMENT

Manjula Weerasinghe¹, Ravi Pieris¹, Flemming Konradsen¹,² and Andrew Dawson²,³,⁴

¹ South Asian Clinical Toxicology Research Collaboration
² Department of International Health, Immunology and Microbiology, University of Copenhagen, Denmark
³ Department of Clinical Medicine, University of Peradeniya, Sri Lanka
⁴ School of Population Health, University of Newcastle, Australia
Background

- The great majority of deaths follow impulsive acts of self-harm, where the ready availability of pesticides in the homes of rural communities play a key role (Eddleston & Phillips, 2004; Konradsen et al., 2006)

- Safe storage devices are an effective avenue for prevention of self-poisoning episodes (Mishara, 2007)
Safe storage devices are an effective avenue for prevention of self-poisoning episodes (Mishara, 2007)

Safe storage has been promoted by a collaboration of industry, IASP, and WHO 2005-7.

But what is the evidence? 2 x Sri Lankan studies

Safe storage interventions should be studied and assessed, since other options such as restrictions, product reformulation or ban of importation are not attractive to the pesticide industry (Konradsen et al., 2007)
Objectives

To assess the long-term use of safe storage devices and identify problems faced with safeguarding the key
Methods

Two study villages in North Central Sri Lanka
Paddy cultivation

Spraying

Houses

Spraying dates

South Asian Clinical Toxicology Research Collaboration
Methods

- Selection of households (200 households of 352)
- Baseline survey
  - Families were clearly informed that they could opt out of the project at any time
- Distribution of devices (June 2005)
  - During distribution and one month after, households were encouraged to store all pesticides in the provided device and keep it locked at all times
- First follow-up (January 2006)
- Second follow-up (June 2007)
- Follow-up surveys coincided with the dry season, the period of maximum use of pesticides
In-house safe storage devices

Large device made of mango wood

Device made of metal

Small device made of mango wood
Baseline - Observations
352 – Registered farming households

200 – Randomly selected households

2 – Refused to take part / replaced by other 2

7 months Follow-up

5 - Closed

23 – Not used pesticides

172 – Remaining for analysis

24 months Follow-up

10 - Closed

29 – Not used pesticides

161 – Remaining for analysis
Definition of locking pesticides exclusively

- All pesticides stored in the device and device locked
- No pesticides visible in the home and home garden areas
- Household members reporting that no pesticides stored in the field
Findings

Pesticides exclusively stored and locked away - among the in-house devices distributed in the villages

- **Baseline** (n = 172)
  - 2%

- **24 months after** (n = 161)
  - 55%
  - 82%
Shifting of pesticide storage place over time

- **Baseline**: 32 House, 22 Garden, 46 Field (n=172)
- **7 months follow-up**: 98 House, 2 Garden, 2 Field (n=172)
- **24 months follow-up**: 67 House, 6 Garden, 27 Field (n=161)
Reasons for not keeping the device locked

- Padlock is not a user friendly locking mechanism
- Impractical to keep opening the device when pesticides are used frequently
  - Difficult if several people are involved in pesticide spraying; or
  - Spraying and key management done by two different persons
- Corrosion and loss of key
- Drawbacks in the design of the devices
Some farmers do not consider keeping the device locked to be important as they think poisoning would not occur in their household.

Keeping the key away from other family members was a big challenge to farmers: at the 24 month follow-up it was revealed that in 57% (n=42) of the households the children could find key within minutes.

Impractical to hide key away from spouse/cultural aspects.

Although farmers were encouraged to use an additional padlock in critical situations, only seven households had opted to use two padlocks.
Key management by gender (n = 135)

- Male farmer, 65%
- Female farmer, 15%
- Both male & female farmers, 20%
Regular access to the hidden key increased the chances of the hiding place being spotted by other family members.
Device key hidden from family members (n=124)

- Deliberate attempt made to hide key - 85%
- No deliberate attempt made to hide key - 15%
Identified advantages of in-house pesticide storage

- Opportunity to intervene and prevent an attempt of suicide
- Not open to either theft or weather
- Useful to farmers who lease (not own) irrigated lands
- Generally, households with a single occupant (no children) opt for in-house storage
Identified disadvantages of in-house pesticide storage

- The keeper of the key is vulnerable to easy access to pesticides
- Most conflicts that lead to self-harm attempts occur in the home environment
- Extra pressure to ensure device locked at all times
- If device is kept unlocked owing to an oversight, accidental poisoning situations may arise
Follow-up observations

Device used for purposes other than storing pesticides

Books

Crockery

Toys
Unused Devices

South Asian Clinical Toxicology Research Collaboration
Modification of devices by farmers

Chambered
Long legs
First aid box
**Acute poisoning cases**

- 12 cases of acute pesticide reported
  - Total population in the two villages - around 1900
  - Four cases at the seven month follow-up and eight cases at 24 month follow-up

- Seven families had received a device
  - [2 deaths – key responsible person] [1 – unlocked device]
  - [1 – forced and opened] [2 – pesticides obtained from outlets]
  - [1 – No clear information]

- Four failed attempts owing to device
Observations
Conclusions

- Provision of in-house safe storage devices had high community acceptance and utilization, especially in the short-term.

- Provision of only in-house devices appears to encourage farmers to store pesticides at home, which may increase domestic risk of impulsive self-poisoning episodes.

- The ability of other household members, especially children, to find the key easily is worrying.
Conclusions (cont’d)

- The person in charge of the key is vulnerable to easy access of pesticides

- Hiding the key from other family members was still a big challenge to farmers

- Improvement of locking mechanism would be one of the best options to switch non-users to users

- Device had posed some barrier for self-poisoning episodes
Next studies 1...

UV resistant plastic design

Modified concrete designs

Next studies 2...
Safe storage website:
www.safestorage.toxicology.wikispaces.net