Health Care Resource:
Links between Pesticide Exposures and Mental Health

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Mental Health Effects from Pesticide Exposure

Exposure to pesticides can have behavioral and psychiatric consequences. The purpose of this resource is to help mental health clinicians and health care providers become aware of the association between pesticide exposure and these consequences and to provide links to relevant research findings.

Many people are at risk of pesticide exposure, including those who:

- work in agriculture, landscaping or other settings (such as grocery stores, schools, daycares and office buildings) in which pest problems are treated with chemicals;
- live downwind from where aerial spraying of pesticides is done;
- live in communities where spray and runoff can contaminate both surface and ground water; or
- live in urban dwellings where pest control is used.

Outside use may take months for the pesticide to degrade to half-life or roughly half potency. Indoors there are no degrading elements such as sunshine, soil or rain to degrade potency; these undegraded pesticides can be re-suspended into the air in dust particles.

Health care providers should consider the possibility that the symptoms associated with mental health disorders, such as irritability, depression or anxiety, may be the result of acute or chronic pesticide exposure. No matter what the presenting ailment may be, clinicians who care for individuals either at risk of pesticide exposure or those with known exposure are encouraged to inquire about the presence of depression, anxiety, or any of the other symptoms listed below.

Mental Health Symptoms of Organophosphate Exposure

The following list of symptoms is based on clinical studies of humans treated with substances that mimic organophosphate (OP) pesticides (e.g., dursban, diazinon, parathion, malathion). These were used either to treat medical conditions or experimentally to understand neurochemical pathways in the brain.

- Fatigue, with or without decreased activity level, which may present as chronic fatigue syndrome
- Irritability
- Impaired concentration
- Confusion
- Headaches and dizziness
- Loss of memory
- Anxiety
- Feelings of hostility
- Excessive sweating or salivation
- Poor or decreased appetite
- Sleep disturbances (increased REM sleep)
- Increased inhibitory responses upon exposure to stressors which are reversed by administration of an antidepressant drug
- Weakness in the arms, legs and hands with loss of coordination
- Epileptiform seizures with high-level exposure
- Altered response to alcohol with a lower tolerance to its effects

Human Studies: Biochemical Evidence

Evidence of neuropsychiatric changes in those exposed to anticholinesterase agents comes from the early use of these OPs as drugs, in laboratory studies on people, and in animal models. Although no longer medically prescribed, diisopropyl fluorophosphate (DFP) and tetraethyl pyrophosphate (TEPP) were used successfully for many years to treat glaucoma, abdominal distention, urinary retention, and myasthenia gravis.[1-3] DFP and TEPP were the earliest OPs found to have insecticidal properties.

Chlorpyrifos and diazinon have been shown to significantly reduce birth weight in urban minority cohorts[4,5] and to shorten gestation and produce abnormal neonatal reflexes in an agricultural cohort.[6] Pesticides may act directly to cause learning disabilities and behavioral problems. Long-term cognitive impairment has been observed in children exposed prenatally to organophosphates.[7,8] Environmental exposures coupled with high maternal stress may permanently alter the developing hypothalamic-pituitary-adrenal (HPA) axis during pregnancy and contribute to co-morbid psychiatric and medical disorders due to excessive hypothalamic (corticotropin-releasing hormone [CRH]) release.[9-11]

Patients with a family history of depression or anxiety are more sensitive to the negative effects of acetylcholine drugs than are those without such a family history.[12,13] Therefore, those with a family history of mood disorders may be at an increased risk of chronic health effects resulting from such exposure.

Research indicates:

- Depressive symptoms can be caused by the depletion of the monoamines norepinephrine and serotonin; [12,13] the symptoms can be reversed by monoamine oxidase inhibitors (MAOs) and tricyclic antidepressants. These drugs increase monoamine receptor sensitivity.[14]

- The most studied OP anticholinesterases, DFP and physostigmine, induce depression or reduce mania in humans.[15]

- Anticholinesterase compounds have been shown to effect many neurotransmitter systems involved in mood, emotion, and behavior including the noradrenergic, cholinergic, serotonergic, and dopaminergic pathways.[16,17]

- Dursban appears to affect serotonin levels at doses lower than those that perturb the cholinergic system.[18]

- More recent research suggests that epinephrine acting at alpha-1 adrenoceptors may also play a role, due to its stress-mediating effects,[17] and is consistent with a previous finding that epinephrine effects are reduced in response to physostigmine in depressed patients.[19]

- The loss of positive, motivated behavior is thought to be due to a reduction of central dopaminergic neurotransmission in basal ganglia.[17] Decreased levels of dopaminergic metabolites are found in the cerebral spinal fluid of depressed individuals.[17]

- Although not as potent as OPs at inhibiting cholinesterase, carbamates (e.g., ficam, sevin, carbaryl, and aldicarb) can lead to mood dysregulation as well. Carbamates can cause memory loss and behavioral problems and are associated with sudden unprovoked extreme agitation, anger, rage, and violence. [20]

Evidence from Animal Studies

Animal studies also support the evidence that anticholinesterase agents can induce mood disorders:

- Rats that have been selectively bred to be sensitive to organophosphate compounds (i.e. DFP) demonstrate that a hyper-responsive cholinergic system may increase the probability of symptoms of organophosphate exposure. [21-24]

- The rats have an increased number of muscarinic and nicotinic acetylcholine receptors in certain brain regions.[25,26]

- Emerging evidence from animal models supports the view that multiple chemical sensitivity syndrome in humans is associated with low-dose, long-term OP exposure.[27]

- Chronic exposure to low levels of OP may lead to tolerance to the effects of the chemical; consequently a higher exposure may be missed because of a lack of symptoms from the exposure.[28-30]

- Primates and rats show detrimental effects on learning and memory with low-dose, chronic exposure to OPs.[31]

Summary

A growing body of research supports the association between pesticide exposure and adverse human health effects including depression, ADHD, anxiety, confusion, memory loss, lethargy, pervasive developmental disorders, unprovoked extreme agitation, anger, rage, and violence.[32,33] Epidemiological evidence suggests that mood changes after acute exposures can continue for many years[34,35] and that repeated high exposures greatly increase the risk of mood disorders.[36] Given that symptoms may not occur until after a period of repeated exposures, health care providers should consider both acute and chronic exposures when evaluating patients.

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