

ORGANOPHOSPHATE PESTICIDE EXPOSURE IN HUMANS – IS PREVENTION POSSIBLE?

ALINA FARCAS¹, CRISTINA FLORIAN¹, ANDREEA VALCEANU MATEI², AND GHEORGHE COMAN¹

¹ *Transilvania University of Brasov*

29 Eroilor Bdv., 500036 Brasov, Romania

² *Emergency County Hospital of Brasov*

25-27 Calea Bucuresti 500326 Brasov, Romania

Correspondence Contact: gh.coman@unitbv.ro

Abstract. In the current context of economic development and population expansion the use of some form of pest control is essential for the maintenance of a high agricultural productivity, of a strict control over the potential vectors of disease and of efficient methods of intervention with least impact on the health of the humans and the environment. However, the current reality shows an alarming number of adverse events in connection with pesticide usage, some of them implicating humans, other affecting other living creatures and the ecosystem. Many of the adverse events are reported in rural situations and in developing countries, raising the question of information dissemination and education about the effects of pesticides on human health and also of the existence and implementation of safety methods and techniques. Also, at the local level, we can raise the issue of educating the public about the methods and behaviors that can reduce contact with environmental pollutants, promote health in the context of pesticide exposure and mitigate health effects of intoxication. The context of organophosphate pesticides use is a complex one, covering agricultural applications, pest management and medical uses, and the possibility of intervention in the direction of reduction and prevention of adverse health effects appears at every level of implementation and management of pesticide usage.

Keywords: pesticide, organophosphate, prevention, human, naturopathic model

1. Introduction

Our human society has evolved in a manner that is more and more heavily dependent on chemical compounds for its continued survival. This arms race finds itself reflected in healthcare in several aspects, from the continuous battle between man and microbes to the struggle to overcome the adverse health effects of various chemical compounds that man has created.

Among the substances that constitute a serious threat to health we can list pesticides. Throughout time, humans have competed with other living creatures for the resources available, and from this paradigm aroused “the need” to gain the upper hand in this race. Combating the natural predators of the various food sources humans have, continues to be an issue to this day (Cooper and Dobson, 2007). On the other hand, public health challenges have been addressed by using some of the same pesticides in combating parasites and pests that were a direct threat to human health in situations characterized by less than ideal economic and social situations (Kesavachandran et. al., 2009).

The substances used historically have evolved, from basic compounds found in nature (of mineral or plant origin) to synthetic pesticides (Casida, 2012). Of interest in the realm of synthetic pesticides are the organophosphate (OP) pesticides, which came to replace the more environmentally persistent, bioaccumulating and biomagnifying organochlorine compounds. However, this class of pesticides, in spite of being less persistent in the environment, presents a high toxicity for humans (Costa, 2006). We focused here on the possible methods of prevention and reduction of exposure to OP pesticides, which represent more than half of the insecticides currently in use (Pesticide News, 1996).

Globally, the main activity areas where we use pesticides are in the agriculture, in the industry/community/governmental sector and finally the home and garden sector. From the total of 2,360,000 tons of pesticide used worldwide in 2007, about 17% were insecticides, amounting to a rough estimate of 405,000 metric tons (US EPA, 2011).

The use of this class of pesticides becomes in itself a public health concern not only because of the large impact that it has on human health (De Silvaa et al., 2006), but also due to the varied and sometimes insidious routes through which humans come into contact with them. There are several situations where humans become exposed to these compounds in such high quantities: occupational exposure in agricultural workers who come in direct contact with the pesticides (Flocks et al., 2007), chronic exposure to foods or materials contaminated with these pesticides (McKinlay et al., 2008), the use of pesticides for addressing public health problems, accidental exposure to significant quantities of pesticides and suicide attempts (Gunnell et al., 2007).

For the purpose of the present work, we will not include in discussion the intentional use of pesticides for self-poisoning, which in itself is a serious concern for public health and has made the subject of numerous studies.

2. Health Effects of Organophosphate Pesticide Exposure

Few people realize the real impact that these chemicals have on human health. The most obvious, is the induction of adverse health effects after acute high dose exposure, where the most prevalent is the cholinergic syndrome/crisis that could lead to death, the intermediate neurotoxic syndrome and later on the delayed polyneuropathy (Borchers et al., 2006). The chronic low-dose exposure is less studied, however there is mounting evidence of the adverse health effects that develop over time, with a certain latency period, after this type of exposure. The most common conditions that have been encountered after chronic human exposure to OP pesticides fall in one of the following categories:

- reproductive effects – such as birth defects, growth alteration, altered fertility;
- neurotoxic effects – seen in the array of neurodevelopmental, neurobehavioral and neurodegenerative diseases that have been linked to such exposure;
- genotoxic effects – mainly represented by chromosomal aberrations resulted after exposure, which may or may not lead to the development of various types of cancers (Bassil et. al., 2007); and last but not least;
- dermatologic effects (Sanborn et. al., 2007).

3. Management of Pesticides

Pesticide use is widespread across the globe, countries in the first world employing them just as much as third world countries do, in an attempt to increase agricultural productivity, stave off diseases, improve the standard of living and overall maintain and even improve the human quality of life (Cooper and Dobson, 2007).

However, there are differences from one country to another when it comes to the type of pesticide employed because different areas face different needs in pest control, countries face financial and public health problems of differing magnitudes from one area to another and some more researched chemicals which have proved too harmful for humans have been phased out or banned in first world countries where costs are easier to cover, while in other countries, with lower budgets and an even lower penetration of information they are still used.

Therefore at the global scale, the groups of population most at risk of harmful effects from pesticide exposure are:

- agrarian populations when compared to inhabitants in non-agrarian areas, and the trend is maintained across the globe without regard to the level of economic development;
- less educated individuals compared to more educated ones – due to the ability to become informed with respect to the adverse effects of such substances and to take the appropriate measures for protection for themselves and others;
- inhabitants of less developed nations compared to more developed ones – because of the trend to unload unwanted pesticides from the first towards the third world, the more permissive legislation in such areas, the pervasiveness of corruption and the lack of public information and transparency in these countries.

When we consider the management of pesticides, it is important to realize the need for a coherent action plan in order to mitigate adverse effects of pesticide use and set the stage for their responsible management from the phases of research and development, through production, storage, dispensation and disposal. Every one of these stages implies human handling and human and environmental contact, and at every stage there are implications of the decision making process.

There are several areas of influence that are involved with the issue of responsible pesticide use, from the individual and his/her immediate community, to the larger community and its various forms of organization – businesses, governments and international groups (Figure 1).

Each of these levels maintains a certain level of control and a particular degree of responsibility attached to their place in the network, an effective strategy only being possible when combining them all.

Transposing these areas of influence towards concrete actions that can become part of a coherent strategy, we can identify several levels of intervention (Figure 2). The big picture is outlined by the methodology and regulation necessary at the local, regional and international levels, based on targets set through international negotiation and cooperation. These targets are informed by the new developments and findings provided by research and all of the information needs to be publicized, disseminated and emphasized at all of the levels of society.

Education is, in this respect, the most important vehicle for accomplishing this task. It has many facets and valences that need to be carefully considered and employed.

When considering prevention, it is very important that all the participants to the pesticide flow be aware of the nature of the chemicals they are handling, the

proper measures for protection and the appropriate routes of dispensing and disposal.

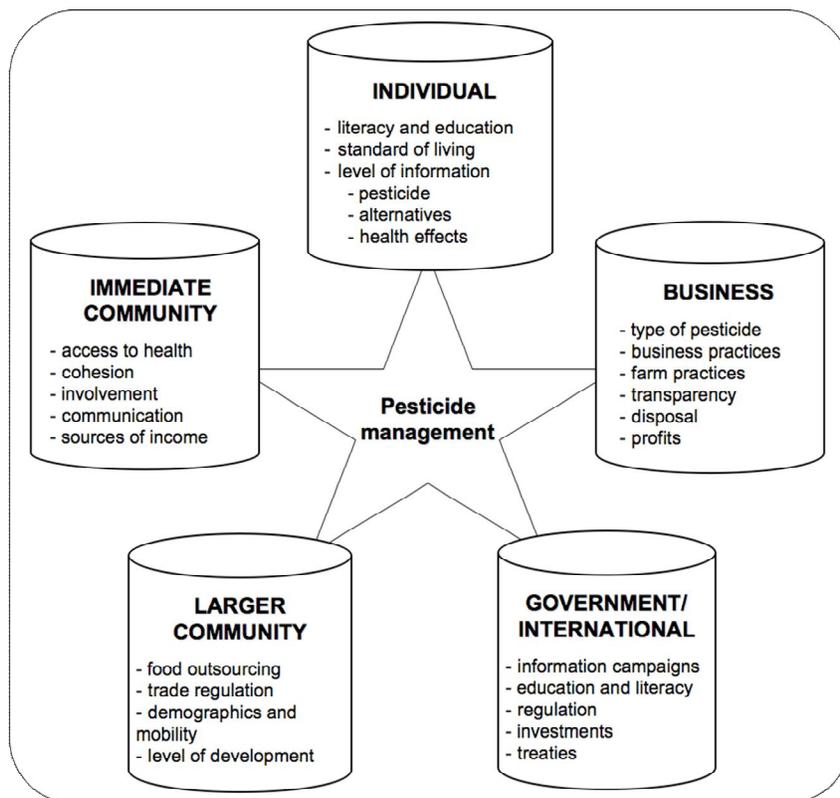


Figure 1. Areas of pesticide management

Also, an important aspect alongside the knowledge about the nature of the pesticide is the accurate information regarding the health effects (symptomatology) of these chemicals, and the manner in which these can be mitigated – dietary choices (organic versus conventional foods, foods rich in antioxidants, food combinations); appropriate prevention measures concerning safety and exposure; timely treatments that are specifically tailored to the problem at hand (Kaushik et al., 2011).

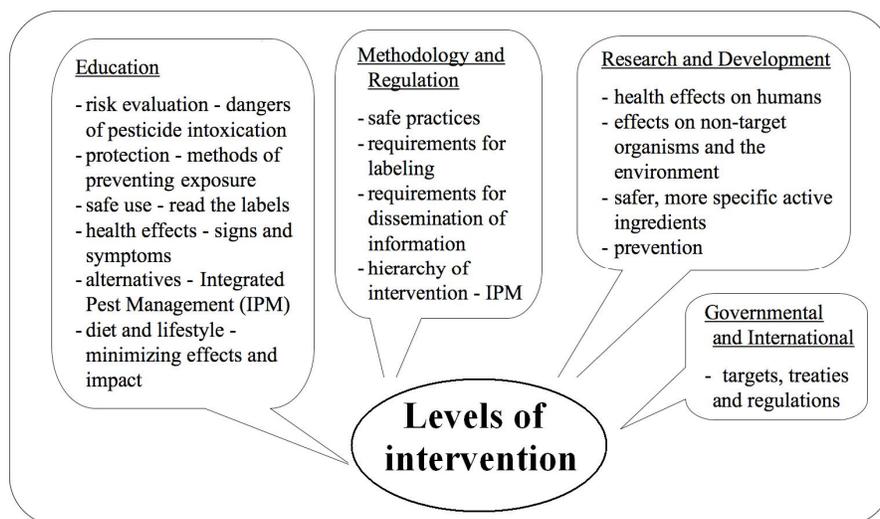


Figure 2. Levels of intervention for pesticide management

4. Naturopathic Earth Care

In the recent years, the concept of integrated pest management has surfaced in connection with the attempt to reduce the impact of pesticides on the biosphere. It consists of a series of principles that guide the choices that are made in each and every pest problem encountered. It is based on thorough and intimate knowledge of the pest at hand (its habits, lifecycle and needs), of the available methods of intervention (from the least to the most invasive) and of the ecology of the loco-regional area where the problem exists. This complex knowledge informs the decision making process, helping to achieve the right amount of intervention for the problem at hand.

A very interesting parallel can be made here with the concepts postulated by naturopathic medicine. Naturopathy as a philosophy of life and health is based on the same six precepts for health that govern medicine in general (Zeff, 1997). These have been coined centuries ago and medical practice is using them to a greater or a lesser extent. (Table 1)

Based on these precepts, naturopathic medicine has drawn up a therapeutic order that aims to match the force of intervention with the magnitude of the problem. In this respect, each individual case will be met with the least force

necessary to correct the problem and allow the organism to heal. The quintessential concept underlying this philosophy is that the physician's job is not to heal the patient but to aid the patient's own natural and inherent healing process (Smith and Logan, 2002).

TABLE 1. Basic percepts of medicine. Naturopathic/Medical Percepts

PRIMUM NON NOCERE - First do no harm.

Try to minimize harmful side effects and avoid suppression of symptoms.

VIS MEDICATRIX NATURAE - The healing power of nature.

Seek to identify and remove obstacles to the body's natural processes for maintaining and restoring health.

TOLLE CAUSAM - Identify and treat the cause.

Focus on the causes of a disease or condition, rather than its symptoms.

DOCERE - Physician as teacher.

Educate patients and encourage them to take responsibility for their own health (partnership for health).

HOLISM - Treat the whole person.

Consider all factors - physical, mental, emotional, spiritual, genetic, social environmental when tailoring treatment to each patient.

PREVENTION.

Assess risk factors and susceptibility to disease, and make appropriate recommendations to maintain health and prevent illness.

Using the pattern of growing complexity from cells to organs to individuals, we can extrapolate further from individuals to groups/communities to ecosystems to the point where the whole biosphere becomes a self-regulating "organism". In this manner we can apply the same concepts of the therapeutic order to the biosphere in regards to pesticide usage and its effects, and health care becomes earth care.

At this point we become aware of the parallel between naturopathic medicine and integrated pest management (Table 2).

A core aspect of the naturopathic philosophy is that treatment must be individualized to meet the needs of a particular patient and the treatment of any disease is the treatment of the person. Similarly, every situation that requires the use of pesticides can be ranked on the scale of severity and matched with a

solution that necessarily takes into account first the prevention, then the integrity of the system treated and the existing alternatives before synthetic pesticides are employed. Also of utmost importance is the rational use of pesticide, where just as in pharmacology we match the pest with the proper chemical in the right amount for the right length of treatment time.

In human health care, the concept of suppression is used for the situation where a treatment employed, which overmatches the magnitude of the problem, leads to a false cure of the patient, instead pushing the disease deeper into the system and masking the real symptoms. On the surface, the patient has been healed of the current ailment, but the real disease has been aggravated. Similarly, in earth care, we can observe situations that are met with a force of intervention which is too high or disproportionate compared to the problem at hand, and the ecological implications are loud, serious and long term.

TABLE 2. Naturopathic therapeutic order versus Integrated pest management

Naturopathic therapeutic order	Environmental therapeutic order/ INTEGRATED PEST MANAGEMENT
REESTABLISH THE BASIS FOR HEALTH Remove obstacles to cure by addressing the determinants of health	CROP ROTATION Maintain the health of the soils by rotating crops and reducing the likelihood of pest overgrowth/overpopulation and soil depletion due to monocultures
STIMULATE THE HEALING POWER OF NATURE Stimulating the healing power of nature by using nutritional, hydrotherapy, psycho-spiritual methods	PEST RESISTANT VARIETIES Select those varieties of crops that can yield the most for the particular area
TONIFY WEAKENED SYSTEMS Strengthen immune system, decrease toxicity, normalize inflammation, optimize metabolic function, balance regulatory systems, enhance regeneration, harmonize life force	NATURAL ENEMIES Foster the natural ecosystem in the loco-regional area; in the local ecology each living organism has its own place in the pray-predator chain.
CORRECT STRUCTURAL INTEGRITY Therapeutic exercise, manipulation,	COMBINED cultures Intercalate crops on the same planting

TABLE 2. Naturopathic therapeutic order versus Integrated pest management

Naturopathic therapeutic order	Environmental therapeutic order/ INTEGRATED PEST MANAGEMENT
massage, physiotherapy.	area, in order to use the natural repelling properties of some plants
PRESCRIBE NATURAL SUBSTANCES /modalities/interventions Specific for pathology	Use of BIOPESTICIDES (Rao et al., 2007) and other NATURALLY DERIVED pesticides
PRESCRIBE PHARMACOLOGICAL SUBSTANCES Specific for pathology	Use of synthetic pesticides RESPONSIBLE CHEMICAL USE
USE SURGERY, suppressive drugs, radiation, chemotherapy Specific for pathology	

5. Conclusion

The effects of pesticide use have to be recognized as a global issue, even though their use is regional or local. Recognition has to be given to the fact that our planet's ecosystem has checks and balances through which it is attempting to maintain its homeostasis, and just as the living organism circulates toxins using blood or sap, the biosphere has its recirculation cycles. This concept helps us understand how our actions at the local level will have global implications, and motivate us to look for alternatives and solutions for which the benefits outweigh the costs for all of the parties involved.

References

- K.L. Bassil, C. Vakil, M. Sanborn, D.C. Cole, J.S. Kaur, K.J. Kerr, Cancer health effects of pesticides: Systematic review, *Can Fam Physician*, 2007, **53(10)**, 1704–1711.

- A.T. Borchers, C. Chang, C.L. Keen and M.E. Gershwin, Airborne Environmental Injuries and Human Health, *Clinical Reviews in Allergy and Immunology*, 2006, **31**, 25-35.
- J. E. Casida, The Greening of Pesticide–Environment Interactions: Some Personal Observations, *Environmental Health Perspectives*, 2012, **120**, 487–493.
- J. Cooper, H. Dobson, The benefits of pesticides to mankind and the environment, *Crop Protection*, 2007, **26**, 1337-1348.
- L.G. Costa, Current issues in organophosphate toxicity, *Clinica Chimica Acta*, 2006, **366**, 1-13.
- H.J. De Silvaa, N.A. Samarawickremab, A.R. Wickremasinghec, Toxicity due to organophosphorus compounds: what about chronic exposure?, *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 2006, **100**, 803-806.
- J. Flocks, JD; P. Monaghan, PhD; S. Albrecht, PhD; A. Bahena, Florida Farmworkers' Perceptions And Lay Knowledge Of Occupational Pesticides, *Journal of Community Health*, 2007, **32(3)**, 181-194.
- D. Gunnell, M. Eddleston, M.R. Phillips and F. Konradsen, The global distribution of fatal pesticide self-poisoning: Systematic review, *BMC Public Health* 2007, **7**, 357.
- G. Kaushik, S. Satya, S.N. Naik, Green tea: protective action against oxidative damage induced by xenobiotics, *Mediterr J Nutr Metab*, 2011, **4**, 11–31.
- C.N. Kesavachandran, M. Fareed, M.K. Pathak, V. Bihari, N. Mathur, and A.K. Srivastava, Adverse Health Effects of Pesticides in Agrarian Populations of Developing Countries, D.M. Whitacre (Ed.), *Reviews of Environmental Contamination and Toxicology*, 2009, **200**, 33-52.
- R. McKinlay, J.A. Plant, J.N.B. Bell, N. Voulvoulis, Calculating human exposure to endocrine disrupting pesticides via agricultural and non-agricultural exposure routes, *Science of the Total Environment*, 2008, **398**, 1-12.
- G.V.R. Rao, O.P. Rupela, V.R. Rao, Y.V.R. Reddy, Role of biopesticides in crop protection: present status and future prospects, *Indian Journal of Plant Protection*, 2007, **35(1)**, 1–9.
- M. Sanborn, K.J. Kerr, L.H. Sanin, D.C. Cole, K.L. Bassil, C. Vakil, Non-cancer health effects of pesticides: Systematic review and implications for family doctors, *Can Fam Physician*, 2007, **53(10)**, 1712–1720.
- Smith MJ, Logan AC. Naturopathy. *Med Clin North Am*. 2002 Jan;86(1):173-84
- Zeff JL. The process of healing: a unifying theory of naturopathic medicine. *Journal of Naturopathic Medicine* 1997; 7: 122-5
- *** US EPA 2011 February, Pesticides Industry Sales and Usage 2006 and 2007 Market Estimates;
- *** Organophosphate insecticides, *Pesticide News*, 1996, **34**, 20-21.