An Evaluation of Occupational Exposures to Pesticides in Brazil

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inhibitory activity towards these enzymes [4,11,14]. In the latter case, especially OP with a P=S moiety are exposed to various biotransformations after absorption, which may significantly change their toxicity characteristics, resulting in the formation of metabolites which are sometimes more toxic than the original substance [12]. Especially so, when the metabolic activation proceeds via enzymes of the cytochrome P450 complex, which results in the formation of oxygen analogues of pesticides (oxons), which in turn inhibit AChE and BchE [4,14]. Furthermore, reversible and irreversible complexes can be formed. OP usually form more stable complexes – sometimes even irreversible - with AChE and BChE, whereas CBM tend to form less stable and reversible complexes [11,15,16]. Evidently, the individual effects of OP or CBM poisoning are determined by the metabolism, and accordingly related to the individual chemical structure [12].

Cholinesterases: AChE and BChE

Based on their substrate and inhibitor specificity, ChE are classified as AChE or BChE. As OP and CBM inhibit ChE reversibly or irreversibly, the assessment of exposure is usually based on the enzyme activity in the blood. This can be accomplished via two ways: (a) by the examination of erythrocytic AChE (erythrocytic separation of the whole blood) and serum BChE activity in the plasma, or (b) by specific inhibitors of BChE, which can be used to enable the analysis of AChE in the whole blood, even though this alternative may cause false positive results [17].

AChE and BChE are responsible for the hydrolysis of acetylcholine (ACh), which is ubiquitous in the nervous system of vertebrates [4,15,18]. AChE is a very important neurotransmitter, and after every synaptic transmission, it must be rapidly hydrolyzed to acetic acid and choline, in order to reconstitute an appropriate state for a new nerve transmission. When the inhibition of AChE and BChE by OP and CBM occurs, AChE remains in the synaptic cleft, resulting in overstimulation. Depending on the blocked receptor present on the surface of the nerve cells, various responses of the central nervous system (CNS) at the neuromuscular junctions are observed [9]. Therefore, the repeated analysis of cholinesterase (AChE and BChE) activity in patients poisoned with pesticides can be a valuable monitoring tool, and help to optimize therapeutic measures. Furthermore, they are useful analyses to confirm exposure, since the pathophysiological data available should allow a correlation between established symptoms and the degree of AChE and BChE inhibition [9,4].

Many methods to measure ChE activities have been developed, and usually involve esters of choline and thiocholine, as they are considered good substrates for AChE and BChE. Normally, ACh is the physiological substrate used to verify the activity of AChE and benzoilcolina is the substrate of choice to analyse the activity of BChE [19-24]. In order to apply these methods in the field, commercially available portable kits can be used [25]. With respect to the method of choice, measuring AChE activity is generally considered to be more specific compared to that of BChE. However, this topic remains controversial, as the BChE activity is more specific for some compounds, e.g. malathion and chlorpyrifos (both OP) [4]. But the analysis of ChE activity is a quick and inexpensive clinical toxicology method that facilitates the diagnosis, monitoring, and choice of treatment for acute cases of poisoning, and it clearly supports clinical and laboratory evidence. Nevertheless, the effects on AChE and BChE activity of frequent, repeated, and prolonged exposures to what are perceived to be low pesticide doses still produce controversial results [9,26]. In addition, several studies of OP and CBM poisoning vary between countries, according to the pesticide purpose and frequency of use, which also results in different types of poisoning [4,27,28]. An estimated 50% of workers are employed in the agricultural sector worldwide, and due to the inherent toxicity of pesticides, usually highly specific and complex legislation prescribes in most countries detailed procedures for the risk assessment of exposure, mostly based on the health monitoring of individuals [2].

In Brazil, the corresponding laws (NR7 and NR31) state that all agricultural workers are supposed to conduct periodic medical

being within acceptable levels of exposure, as required by Brazilian law (BChE 50%, AChE 30%, 25% whole blood). When the number of individuals with reduced enzyme activity is observed, it may be concluded that in relation to the number of samples, these findings remain rare. Although most of the observed studies use the same methods, the presented results vary, mainly because the diversity of interpretations between laboratories may reflect important causalities, e.g. time elapsed between exposure and sample collection (possible recovery of the enzyme activity), adopted reference values, or restricted access to methodologies and advanced equipment.

Studies	Populations exposed to pesticides	Results

recommendations from manufacturers. These values are either based on mean population values of unexposed individuals, or on the

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