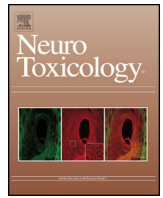




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NeuroToxicology



Communicating pesticide neurotoxicity research findings and risks to decision-makers and the public

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ABSTRACT

The extensive research findings on neurotoxic risks of pesticides tend to remain in academic publications rather than being comprehensibly communicated to decision-makers and the public. Protecting health and promoting risk reduction, particularly in developing countries, requires access to current findings in a format that can inform policy, regulations, behaviour change and risk reduction. Successfully communicating research findings may require multiple strategies depending on the target audience's varying comprehension skills (e.g., numeracy literacy, visual literacy) and ability to interpret scientific data. To illustrate the complexities of risk communication, a case study of exposure to neurotoxic street pesticides amongst poor, urban South African communities attempting to control poverty related pests, is presented. What remains a challenge is how to communicate neurotoxicity research findings consistently and in a meaningful manner for a lay audience, consisting of both the general public and decision makers. A further challenge is to identify who will monitor and evaluate the ways in which these findings are communicated to ensure quality is maintained. Ultimately, researchers should carry the responsibility of knowledge translation and engaging with communication specialists when appropriate. Additionally, institutions should reward this as part of promotion and academic accolade systems, and funders should fund the translational process. Ethics review boards should also play an instrumental role in ensuring that knowledge translation is part of the ethics review requirement, while professional societies should take more responsibility for disseminating research findings to non-academics.

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1. Introduction

Research findings detailing the long-term health effects of neurotoxic pesticides need to be communicated in such a manner that a lay audience, including decision-makers, pesticide users and the general public, can use this information to reduce and manage risk. Understanding health risks and the associated research findings is the crucial prerequisite to decision-making and promoting behaviour changes. For evidence-informed decision-making to be valid and appropriate risk reduction behaviours to occur, the lay audience must understand the information as accurately as possible. However, researchers seldom perform the complicated task of communicating risks and uncertainties findings to target audiences. Research findings of neurotoxicological effects associated with pesticide exposures should thus be

accessible and comprehensible to decision-makers and the public, particularly in developing countries, for multiple reasons.

Current health research paints a picture of severe risks for users and the public exposed to possible neurotoxic pesticides. Many pesticides, which control pests, fungi or weeds through disrupting cellular mechanisms or targeting nervous systems (Costa et al., 2008; Keifer and Firestone, 2007), are neurotoxic to humans (Bjørning-Poulsen et al., 2008). Exposure to neurotoxic pesticides is high in developing countries in agricultural and domestic contexts. Moreover, sensitivity to exposure is higher amongst vulnerable populations in these countries; particularly women, children (child labour continues in many developing countries), the elderly, the immune-compromised and malnourished. Examples of populations at risk include farmers, farmworkers, pest control operators, malaria control applicators and bystanders (Ngowi et al., 2013; Kegley et al., 2003; London et al., 2002; Singer, 1999). Evidence of chronic neurotoxic effects (London, 2009; Wesseling et al., 2002), including effects on the brain, particularly those of children, are a key concern (Grandjean et al., 2006; Rohlman et al., 2005; Weiss,

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2000). This situation characterized by high exposure to neurotoxins combined with vulnerable populations, requires urgent risk reduction and mitigation measures.

While research results are not always conclusive, they provide risk information relevant to the development of pesticide legislation and policy, for developing exposure reduction and control mechanisms, and for the development and implementation of interventions. Decision-makers and those tasked with implementing pesticide legislation have access to a hierarchy of control and prevention mechanisms used in occupational and environmental health for risk reduction, which should be implemented in line with research findings. These include elimination of the pesticide, substitution of the pesticide, implementing engineering and administrative controls, changing behaviours, and advocating the use of PPE (Quality Systems and Toolbox, 2013; Runyan, 2003). Hyder and colleagues (2011), in their research with policy makers from low and middle income countries, identified that decision-makers value access to research findings. This suggests that with better access to research findings policy makers are likely to respond with more relevant policies.

To reduce risks, pesticide users, both in the work and home context and the general public require health risk and potential health risk information to be communicated in a manner different than for decision-makers. The information required for this group needs to be relevant for individual behaviour changes and for the public to understand why exposure reduction behaviours are needed to prevent short- and long-term health effects. Little has been published on the impact of the public having access to research findings, unless these individuals participated in a research study. The public is not a homogenous group easily targeted through one channel. Quandt and colleagues (2004) argue that risk communication mechanisms and processes exist for communicating general risk messages, but not to transfer specific risk messages linked to specific exposure outcomes or research findings, particularly in relation to pesticides. Currently, research scientists predominately publish their results in journals or present them at subject specific conferences which limit the dissemination of their findings to decision-makers or the public. The focus of this article, therefore, is on improving communication of research findings linking neurotoxic pesticides and potential health effects for a lay audience.

This article starts by briefly looking at what is understood by risk communication, the goals of communication and its evolution. Then it examines key issues researchers need to take into account when translating research findings for decision-makers versus the general public. To illustrate these points, a case study is presented. Lastly, the article concludes with recommendations for researchers, funders, institutions and professional societies identifying how each can promote a better lay understanding of neurotoxic risks from pesticide exposures.

2. Communicating risks

2.1. Risk communication

Risk communication is generally characterized as the provision and exchange of information regarding the nature, extent, consequence, and control of a threat (Miller and Solomon, 2003; Rother, 2005). More progressive risk communication endeavours, particularly in developed countries, view this process as a two-way exchange of information between experts and a target audience. The risk communication process in developed countries has evolved through numerous stages redefining the goal each time by building on previous stages (Fischhoff, 1995). This transition has been from being seen as a means of brain washing by experts and industry, using a top-down approach to information provision, to

community engagement and participation in a two-way communication process (Morgan et al., 2002). The communication objectives, however, continue to vary depending on the agenda of the risk communicator. Some of these goals include communicating risks to promote intended safety behaviours (motivating action); building trust in the communicator, such as in government or industry; initiating a public participation process to change or influence the public's perception of a particular risk, to educate and raise awareness, and to reach agreement on an issue (Frewer, 2004; Morgan et al., 2002; Rowan, 1991). The goal of risk communication depends on both agenda and target audience. For example, informing farm workers of potential neurotoxic risks from exposure to organophosphates to increase respirator use compliance differs from informing decision-makers that chlorpyrifos requires stricter legislated controls when used in agriculture to reduce exposures and potential neurotoxic effects.

In the context of this article, risk communication is viewed as a process of information provision or knowledge transfer about risks, particularly in relation to their magnitude and reduction measures to promote informed decision-making. Ideally risk communication should be a two-way exchange of information between the lay audience and experts in order to develop common initiatives for reducing risks (Hampel, 2006). Although this is an ideal to strive for in developing countries, the initial process needs to focus on:

- (1) improving access to and provision of coherent information about risks and uncertainties, that is, fostering "right-to-know" and
- (2) providing additional means to support understanding of risk communications, that is, fostering a process to support the "right-to-comprehend" this information (Klaschka and Rother, 2013; Rother, 2011).

An important issue with risk communication is to identify whose responsibility is it to communicate potential health risks to various audiences. In this article, I argue that researchers have a responsibility to share their peer reviewed and scientifically sound research findings. They particularly have a responsibility in sharing findings that illustrate a negative effect and uncertainty of a causal effect. I further argue that institutions and professional societies play a key role in supporting the practice and training of researchers in communicating their findings, and that academic merit should be awarded for these efforts.

Although this article focuses on the type of information required when communicating potential risks and the relevant mechanisms used for communicating these, it is important to understand that the context and frame of reference within which this communication takes place impacts on the understanding, or a lack of understanding, of the information presented. Researchers are not communicating their findings into a vacuum, but instead decision-makers and the public may have preconceived perceptions such as beliefs or attitudes about pesticide neurotoxic risks influenced by various sources, including social structures, cultural beliefs, and media reports. Indeed, sometimes risk communication mechanisms are used to alter lay audiences' perceptions of a particular health or environmental risk. What needs to be taken into account is that risk perceptions influence the understanding of risk communication mechanisms (Rother, 2011), and that various theories and methodologies exist to document and understand these (Morgan et al., 2002).

3. Communicating research findings

This section examines key issues for communicating research findings that researchers need to be cognisant of and particularly

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