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**EDITORIAL**

# Pesticides, soft tissue sarcoma and non-Hodgkin lymphoma

JOHN SPINELLI

Dr. Hardell presents a review of his and other Swedish research examining the effects of pesticides on the risk of soft tissue sarcoma (STS) and non-Hodgkin lymphoma (NHL) [1]. Dr. Hardell's publications were among the first to suggest an association between pesticides (herbicides and insecticides) and these cancers. Many other studies with much larger sample sizes, both positive and negative, have followed. These studies used traditional epidemiologic methods [2] and more recently, biomarkers of exposure [3–5]. While there is now sufficient evidence to conclude that there is likely a causal relationship between pesticide use and lymphatic malignancies, it would have been impossible to make this conclusion based solely on these initial studies in the late 1970s. Even today the causal mechanism involved is not clear [2].

In the late 1970s and 1980s, regulations governing the use of chlorophenols, phenoxy-herbicides and other persistent organic pollutants (including dioxin and organochlorine pesticides) were enacted. Although the carcinogenicity of these substances was not clearly established, the environmental impact and the other toxic effects, as well as the results of the studies by Dr. Hardell and others, led to restrictions in their use which have greatly reduced exposure. This reduction in exposure may be responsible for the reduction in the incidence of NHL in recent years; however, it is also possible that factors entirely unrelated to these exposures have been responsible for the NHL reduction in recent years.

The regulation of phenoxyacetic acid herbicides (including 2,4,5-T and 2,4-D) highlights the difficulty of choosing the appropriate preventive measures and implementing them. Exposure to 2-4-5-T has been associated with an increased risk of STS and NHL in studies by Dr. Hardell and many others, while other studies did not find an association [2]. The causal mechanism is thought to be TCDD contamination in the production of some formulations of 2,4,5-T. TCDD is the most toxic form of dioxin, and is now classified as a human carcinogen [6]. The evidence of carcinogenicity of dioxins other than TCDD has not been established, and 2,4,5-T was banned in many countries in the 1970s and 1980s.

Dioxins, including TCDD, are also created in the production of other phenoxy herbicides such as 2,4-D. These pesticides have been associated with cancer in some studies, although less consistently and with less strength of association. 2,4-D has been banned in some countries, but is still in use in many others. 2,4-D was also contaminated by dioxins, although at lower levels than 2,4,5-T, and the dioxin levels have been greatly reduced due to better quality control in the production of these chemicals [4]. It is not clear whether improving the manufacturing process to reduce or eliminate dioxin contamination in 2,4,5-T, rather than an outright ban, would also have reduced the risk from exposure to this pesticide. Nor is it clear whether a ban on the use of 2,4-D was warranted.

In fact, the major source of dioxin exposure in the United States is not from contamination in industrial products such as pesticides. It is from combustion processes, primarily municipal and medical waste incinerators and uncontrolled backyard waste burning, although dioxin exposure from large incinerators has been reduced due to improvements in incineration technology in recent years [7]. The lesson to be learned is that the actions taken to reduce carcinogenic exposure need to be informed by research; simple solutions may have little effect in public health.

The precautionary principle as a strategy for risk management and the role of epidemiology in the application of this principle have been greatly debated, and I will not attempt to add to that debate

Correspondence: John Spinelli, Cancer Control Research, BC Cancer Research Centre, Vancouver, Canada. E-mail: jspinelli@bccrc.ca

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here [8–14]. I do believe that epidemiology has an important role in the development of environmental policy related to health today and in the future. Chemicals are still being introduced into the environment with little or no information on their human health effects. Several of these have been in the news recently including plasticizers, flame retardants, perfluorochemicals and endocrine disrupters such as BPA. It is clear that we need immediate information on the current levels of human exposure, more research into the toxicology of these chemicals and molecular epidemiologic studies using markers of cancer risk to evaluate their impact on human health. In addition, we should be storing biologic samples in the large cohort studies which will allow us to examine the cancer risk associated with these substances in the shortest possible time. Funding for these initiatives needs to be made available, preferably by industry through unrestricted research grants, but also through public funding agencies. Without the implementation of these research initiatives and planning for further studies, there will continue to be unnecessary delays in the identification of environmental health effects and the implementation of preventive measures.

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