Industry

Agents of concern in the workplace are often the same agents of concern to the community. However, generally speaking – for both radiation and chemicals – the greatest exposures (in terms of concentration and duration) invariably occur in the workplace, as opposed to the home and community. Therefore, studies of exposed workers are often undertaken before community and general population studies are launched, under the assumption that if the higher workplace exposures are not associated with increased health risks, then it is unlikely that the lower levels of exposure experienced by the general population are hazardous. The assumption here is that the public at large is equally susceptible, which likely is untrue.

Two industries of particular importance in Canada – pulp and paper milling and metal mining and processing – are discussed here. Both are known to release substances that can contaminate the environment.

There are pulp and paper mills in every Canadian jurisdiction except Prince Edward Island and the territories.[1] The waste water (effluent) from pulp and paper mill processes has been known to contain many potentially hazardous chemicals that have had profound impacts on the environment. Large volumes of water are used in pulp production. Depending upon the type of mill and the processes used, several chemicals are used to break the wood down into discrete fibres, to bleach the pulp, and to achieve the properties required for the various paper products. For the period of this review, the most widely used chemical was chlorine. Dioxins and furans can be formed from elemental chlorine reacting with the naturally occurring components of wood. Effluent quality has vastly improved since the 1992 Pulp and Paper Effluent Regulations were promulgated. However, effects on fish and fish habitat are still being seen and further monitoring is needed.[2] Canadian mills have eliminated elemental chlorine bleaching and moved to either total chlorine free bleaching (hydrogen peroxide) or elemental chlorine free bleaching (hydrogen peroxide and chlorine dioxide). In addition, effluents are treated to reduce the levels of any chlorinated organic compounds before being discharged to the aquatic environment. Air emissions from pulp and paper mills include sulphur dioxide, nitrogen oxides, hydrogen sulphide, volatile organic compounds and particulate matter.[3]

Large-scale extraction of metals presents hazardous waste management problems. Types of contamination can include waste rock, tailings and slag, contaminated ground and surface water from leaching and runoff, and contaminated soil and surface water from settled air pollutants. Some contaminants of particular concern are arsenic, nickel and mercury. In Canada, higher concentrations of arsenic and nickel have been found near smelters and gold-mining and ore-roasting operations.[4] Mercury, of both natural and industrial origin, is readily transformed into organomercurials by micro-organisms and bioaccumulates up the food chain. Other substances to which workers in the metal mining and processing industry are exposed include radon gas, cobalt, asbestos, cadmium, copper, lead, zinc, cyanide, diesel fuels and emissions, oil mists, blasting agents, silica and hydrogen sulphide.

The majority of studies of cancer and the pulp and paper and metal extraction industries have involved occupational rather than community exposures. One of the challenges of occupational cancer epidemiology lies in estimating exposure among workers. In some work environments (e.g., where radiation is the main exposure), records from personal monitors worn by workers throughout their careers are available. However, in other settings, exposures must be inferred from job titles. More recently, job-exposure matrices have been developed – accompanied by measurements of specified tasks – with the objective of more accurately reflecting actual exposures. Retrospective modelling of exposures is difficult, as higher exposures tended to occur before they were known to be harmful and measurement of exposures was not done at that time.

As with air pollution, workplace exposure estimation now makes extensive use of mathematical modelling. For example, a study of Canadian nickel workers used a Bayesian probabilistic framework to estimate historical exposures to nickel species (soluble, oxidic, sulfidic, and metallic), diesel particulate matter, and silica over a 50-year period from 1950 to 2000.[5] This sophisticated approach involves several steps. First, both sparse exposure data and expert judgement based on plant operating data and physical modelling are used to provide exposure estimates. Secondly, lung burden is estimated as a function of time from first exposure for each worker (using a lung deposition model) and pharmacokinetic data on retention and clearance of inhaled nickel, diesel, and silica (found in the published literature). Thirdly, job-location-year-exposure matrix information is combined with individual job histories for all study subjects to calculate the cumulative exposure metric (with associated uncertainties) for the four nickel species, diesel particulate matter, and silica.

References

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