Preventing occupational cancer starts with data

Australian researchers have developed an IT tool for evaluating the exposure to carcinogens in a large number of industries. Used to process responses to a survey of 5,000 workers on their occupational exposure to carcinogens, it delivered concerning results: two Australians out of five are exposed to at least one carcinogen at work.

Lin Fritschi and Renee Carey
School of Public Health, Curtin University, Perth, Western Australia

The Australian study showed that the jobs most exposed to carcinogens were those of farmers and drivers of various types of vehicles.

Image © Belga
Occupational cancer is complicated. There are many different chemical and physical exposures at work which can cause many different types of cancer. The exposures to these carcinogens occur in many different jobs and are associated with different tasks. For example, demolition workers who remove asbestos lagging can contract mesothelioma and lung cancer, workers in rubber factories can develop bladder cancer, and outdoor workers may suffer from repeated skin cancers.

These occupational cancers may occur many years, or even decades, after the relevant work exposure, so in order to prevent cancer in the future, we need to act now. We already know a lot about what chemical or physical exposures in the workplace result in cancer. In many cases, we also know how to reduce exposure to these carcinogens. However, despite all this knowledge, it is not difficult to find workers who are still exposed to known carcinogens, even in high income countries. For example: bricklayers who cut bricks without masks; and miners who work underground with high levels of diesel exhaust.

How should we address this gap between what we know should happen and what does happen in the real world? One barrier to action is the complexity of the situation with multiple carcinogens, in a huge range of different jobs and industries. It was difficult enough to reduce cigarette smoking, which is just one carcinogen – how can we address multiple carcinogens, in a huge range of different jobs and industries? We can’t do everything, so where should we act?

These were the questions we asked ourselves a number of years ago. We thought there should be some way to determine how many workers were exposed to carcinogens at work so we could really understand the national landscape of risk and provide evidence to policy makers on where the problems existed. We wanted to find out how many workers were exposed to occupational carcinogens and what control measures were (and weren’t) being used. In particular, we wanted to know whether some workers were doing jobs or tasks where high levels of exposures to carcinogens occurred. We also wanted to know whether exposure to carcinogens was more common in sub-groups of workers, such as rural workers, younger workers, or migrant workers.

**Our approach**

Our method is based on the expert assessment method which was pioneered by Professor Jack Siemiatycki in the 1980s. He argued that rather than asking people what chemicals they were exposed to at work, it was better to ask them what they did at work (their tasks), and then engage experts in occupational hygiene to review the answers and assign exposures to carcinogens. This method has been used successfully throughout the world, but trained experts are hard to find, expensive to employ, and take many months to review the thousands of jobs in each study.

In around 2008 we realized that if these questionnaires were written carefully, we could use newly developed computing methods to replace the experts. There have been lots of studies about the levels of exposure to carcinogens in various jobs. More pertinently, many of these studies identify the factors which determine how much exposure workers receive (the determinants of exposure).

For example, they might find that the type of engine or the distance the worker is from idling vehicles makes a difference to the level of exposure to diesel engine exhaust. We decided that we could use the results from these studies to design questionnaires which clearly identified whether or not determinants of exposure were present. We could organize a set of questions about a particular process into a task module. For example, we could have a painting task module for questions about preparing surfaces for painting, painting, and cleaning equipment at the end of the job. Then we could construct job modules from the task modules. For example, a job module for painters might include the task modules for painting, cutting wood, gluing, and driving. In turn, the painting task module would also be asked in job modules such as those for construction workers, farmers and janitors. Where appropriate, we could also gather information about protective measures used (including ventilation, respiratory equipment, gloves, and other protective clothing).

Once we had done that, we could then develop rules which would assign whether workers were exposed to each carcinogen. For example, if a worker said he worked in a large warehouse, close to many idling diesel trucks, a rule would assign high level exposure to diesel engine exhaust; whereas if a worker drove a petrol-engine car on country roads only, a rule would assign no exposure to diesel engine exhaust. We could use experts and existing studies to develop these rules and therefore use the expertise of the world’s best occupational health researchers to create a system which assessed exposures transparently, reproducibly, and rapidly.

The computer application we developed is known as OccIDEAS, which stands for Occupational Interactive Database Exposure Assessment System. It can be used for all stages of the process of assigning exposure to workers, including presenting the right questions to workers depending on their previous answers, assessing the exposures automatically, and providing exposure data as downloadable files. OccIDEAS provides a practical and transparent way to assess exposure to carcinogens in large numbers of people in diverse occupations.

**The Australian Workplace Exposures Study (AWES) – Cancer**

We used OccIDEAS in a study which aimed to determine the number of workers in Australia who were exposed to carcinogens at work, what tasks were most commonly resulting in exposure to carcinogens, and what controls were being used.

We selected 38 agents which had been classified by the International Agency for Research on Cancer as either carcinogenic or probably carcinogenic to humans. They included combustion products (e.g. diesel engine exhaust), dusts (e.g. asbestos, silica, and wood dusts), metals (e.g. chromium, lead and nickel), radiation (e.g. ionizing and solar radiation), shiftwork, and other industrial chemicals (e.g. benzene, formaldehyde).

We obtained a list of landline and mobile phone numbers from a commercial company, and our interviewers called them to ask if they would be in our study. We selected people who were aged between 18 and 65 and currently in paid employment and obtained complete interviews from 4,993 people.

**Workers were more likely to be exposed if they were male, were qualified tradespeople, or worked in regional areas.**
We found that over half of all firefighters never or only sometimes used breathing apparatus with certain tasks.

The interviewers asked each participant for their age, gender, postcode of residence, country of birth, and education level. They then asked for their job title and the main tasks they did in that job. From this information, in consultation with the participant, they chose the most appropriate job module and used the job modules to ask about tasks in the participant’s current job. Interviews took about 15 minutes depending on the number of tasks a worker commonly did.

We have also been able to dig down further into particular exposures. We found that the most common source of exposure to formaldehyde was not laboratory or chemical industry tasks, but occurred when people cut and sanded composite materials such as plywood and particle board. Most of these workers did not use tools with inbuilt dust collectors or wear masks. Another unexpected source of formaldehyde exposure was to firefighters who don’t use breathing apparatus during the clear up phase after fires.

We can also look in detail at particular jobs. For example, road transport workers were not only exposed to diesel exhaust and benzene from driving but many of them also maintained and cleaned their own vehicles, resulting in exposure to benzene and asbestos.

What we found and how it has been used

Of the nearly 5,000 participants, we found that 1,879 were exposed to at least one carcinogen at work. Unsurprisingly, workers were more likely to be exposed if they were male, were qualified tradespeople, or worked in regional areas. When we multiplied the numbers to get an estimate for the whole Australian working population, we found that 2,700,000 men and nearly 900,000 women were exposed to at least one carcinogen at work - this equates to 58% of the male working population and 21% of the female working population. Overall, 2 in every 5 workers were exposed to at least one carcinogen at work.

Jobs which commonly involved carcinogen exposure were farmers and drivers of various types of vehicles. Being in Australia, a lot of work was done outdoors, and solar radiation was the most common exposure. Almost a quarter of all workers were exposed to solar radiation. Diesel engine exhaust, second hand tobacco smoke, benzene, wood dust and silica were also common exposures.

This broad brush information has given us an overall picture of carcinogen exposure in the national workforce. Before our study, it wasn’t obvious that more exposure occurred in rural regions than urban centres. And we did not realize that so many workers were still exposed to second hand tobacco smoke, in a country with very strict anti-smoking regulations. When we looked at this more closely, we realized that much of this exposure came from outdoor lunch locations, or from smokers clustering around entrances to buildings. Regulations have recently changed in many states to prevent smoking near entrances, so we would expect this exposure to have now decreased.

When we looked at farmers and farm workers we found that all of them were exposed to at least one carcinogen and most of them were in fact exposed to multiple carcinogens, including solar radiation, diesel exhaust and various solvents. Only about 2 in every 3 farmers were exposed to pesticides, and pesticides were only the sixth most common exposure. This suggests that health and safety initiatives in farmers should not simply concentrate on pesticides, but address a wide range of exposures.

Further, we can look at the control measures which were commonly used by workers. For example, we found that over half of all firefighters never or only sometimes used breathing apparatus with certain tasks. In terms of sun exposure, most workers used at least one form of sun protection, although less than 10% of workers used a hat, long sleeved shirt, shade and sunscreen for more than half the time they were in the sun. This suggests that more attention should be paid to the appropriate use of controls.

SafeWork Australia, which provided funding for this study, has used the results in various guidelines and information. They also find our studies useful in suggesting areas for proactive interventions. The Cancer Council Australia, who also provided funding, has used our data to prioritize the carcinogens to target in various resources. Results from the study have been used by other researchers in their studies, and have been used by trade unions in Australia and internationally to raise awareness of the importance of carcinogens at work.

In a follow-up study, we recruited migrant workers to answer the same questions and find differences in exposure to carcinogens between workers of different ethnicities as well as differences compared to Australian-born workers. We also found that some migrant groups had more exposure to carcinogens even when doing the same jobs as the Australian-born, and that exposures were more common among workers who chose to answer questions in their own language rather than in English. This has resulted in increased focus by migrant support organizations on conditions of work for migrant workers, particularly for those with less English fluency.

Further studies have examined occupational exposure to agents which cause asthma, and to noise and chemicals which cause hearing loss.

Acknowledgements: We would like to acknowledge the invaluable collaboration of Troy Sadkowski from Bhtan Data Scientists who has led the IT development of OccIDEAS since the beginning, the experts who helped us develop the questions for AWES-Cancer (Deborah Glass and Geza Benke) and the funders of AWES-Cancer (The National Health and Medical Research Council of Australia, SafeWork Australia, the Cancer Council Australia, and the Cancer Council of Western Australia).

Further reading


