chest symptoms or asthma, and these constitute about a quarter of all hazard evaluation requests. We have established the phenomenology of building-related asthma in studying employees in several buildings with water incursion through the building envelope. These populations have had excesses of physician-diagnosed asthma up to 3.3-fold expected rates, incidence density ratios of asthma up to 7.5-fold after occupancy compared to before occupancy, and exposure-response relations between symptom risk and biomass in vacuumed dust.^{10, 11} Building dampness can be considered an emerging cause of occupational lung disease because we are still unsure of causal agents (other than markers of dampness) and immunological mechanisms of dampness-associated asthma.

Although 80% of COPD is attributable to smoking, most of the remainder is likely to have occupational causes. After excluding physician-diagnosed asthmatics, an analysis of national survey data found that many industries have excess measured airflow obstruction.¹² Industries and occupations with statistically significantly increased odds ratios over two in either non-smokers or in all subjects (adjusted for smoking and other factors) include rubber, plastics and leather manufacturing; textile mill products manufacturing; food products manufacturing; utilities; construction trades and labourers; armed forces; records processing and distribution clerks; and freight, stock and material handlers. Although some of these observations may be explained by known exposures

(that is, byssinosis due to cotton dust in textile manufacture, asthma among bakers due to flour dust, and bronchiolitis obliterans due to flavourings in food manufacture), the potential causes and effective interventions are unknown in many of these industries and occupations.

In summary, population-based multidisciplinary follow-up of sentinel cases can enable occupational health professionals to recommend risk-based preventive measures for emerging lung diseases. Prevention of emerging occupational lung diseases is warranted and possible without knowing specific aetiologies and corresponding safe exposure levels. The preventive opportunities of the last 10 years and those for emerging risks can be strengthened with follow-up evaluations to show the effectiveness of implemented interventions.

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REFERENCES

- 1 Washko RM, Day B, Parker JE, *et al*. Epidemiologic investigation of respiratory morbidity at a nylon flock plant. *Am J Ind Med* 2000;**38**:628–38.
- 2 Kreiss K, Cox-Ganser J. Metalworking fluid-associated hypersensitivity pneumonitis: a workshop summary. *Am J Ind Med* 1997;**32**:423–32.
- 3 Hnizdo E, Sylvain D, Lewis DM, *et al*. New-onset asthma associated with exposure to 3-amino-5-mercapto-1, 2, 4-triazole. *J Occup Environ Med* 2004;**46**:1246–52.
- 4 Kreiss K, Gomaa A, Kullman G, *et al*. Clinical bronchiolitis obliterans in workers at a microwave popcorn plant. *N Engl J Med* 2002;**347**:330–8.
- 5 Porter DW, Castranova V, Mercer R, *et al*. Acute inflammatory reaction in rats after intratracheal instillation of material collected from a nylon flocking plant. *J Toxicol Environ Health Part A* 1999;**57**:25–45.
- 6 Klink KJ, Meade BJ. Dermal exposure to 3-amino-5-mercapto-1,2,4-triazole (AMT) induces sensitization and airway hyperreactivity in BALB/c mice. *Toxicol Sci* 2003;**75**:89–98.
- 7 Gordon T, Nadziejko C, Galdanes K, *et al*. *Mycobacterium immunogenum* causes hypersensitivity pneumonitis-like pathology in mice. *Inhal Toxicol* 2006;**18**:449–56.
- 8 Hubbs AF, Battelli LA, Goldsmith WT, *et al*. Necrosis of nasal and airway epithelium in rats inhaling vapors of artificial butter flavoring. *Toxicol Appl Pharmacol* 2002;**185**:128–35.
- 9 Institute of Medicine. *Damp indoor spaces and health*. Washington, DC: National Academies Press, 2004.
- 10 Cox-Ganser JM, White SK, Jones R, *et al*. Respiratory morbidity in office workers in a water-damaged building. *Environ Health Perspect* 2005;**113**:485–90.
- 11 Park J, Cox-Ganser J, Kreiss K, *et al*. Fungal and endotoxin measurements in dust associated with respiratory symptoms in a water-damaged office building. *Indoor Air* 2006;**16**:192–203.
- 12 Hnizdo E, Sullivan PA, Bang KM, *et al*. Association between chronic obstructive pulmonary disease and employment by industry and occupation in the US population: a study of data from the third National Health and Nutrition Examination Survey. *Am J Epidemiol* 2002;**156**:738–46.

Cancer

Investigating cancer risks related to asbestos and other occupational carcinogens

Jack Siemiatycki

There will be little progress without investment in exposure assessment

It has been half a century since asbestos was recognised as a lung carcinogen.¹ Asbestos may well be the most studied occupational carcinogen and it is indeed virtually an icon for industrial carcinogenesis. National bodies have taken action to restrict or ban asbestos use

and analogous international initiatives have been undertaken as well.² Asbestos use has been sharply curtailed in developed countries, though the same is not true in developing countries.^{3, 4} Even if it were eliminated in all new uses, asbestos would still remain in the occupational

environment, especially in construction trades,^{5, 6} and it would remain in the general environment, both from past industrial/consumer products and from erosion of natural outcroppings of asbestos-containing rock.⁷ Despite the large number of studies that have examined asbestos, there are important questions which are still controversial, such as differences in risk by fibre type, by industry and by level of exposure.^{8, 9}

Whereas most of the studies that have identified high risks of lung cancer were cohort studies among workers whose exposure was mainly in the period 1940–70, studies conducted on more recently exposed workers, and studies using case-control methods, have generally not found clear evidence of excess risks of lung cancer. This may well be due to lower exposure levels, shifts in the types of asbestos used, or methodological differences between cohort and case-control approaches. The results reported

by Carel *et al* from a multicentric study in eastern Europe and England are compatible with these generalisations. Apart from the small English component, the overall finding is null. This is somewhat surprising in light of the widespread perception that industrial hygiene conditions were poorly controlled in eastern Europe in the Soviet era.¹⁰ The ostensible difference between the relative risks due to asbestos between eastern Europe and the UK could be due to any of several factors: differences in exposure levels for the same jobs (but this seems unlikely in light of industrial hygiene conditions in eastern Europe), differences in types of asbestos used (but there is no strong evidence of different risks of lung cancer by fibre type), differences in industrial profiles leading to more high exposure jobs in the UK, differences in the quality of exposure assessment, or in some other artefactual conditions. Because of continued widespread exposure to asbestos, in both developed and developing countries, it remains important to try to nail down the determinants of risk of lung cancer related to asbestos exposure. This study provides an important, but not definitive piece of the puzzle.

It is clear that as much as 90% of lung cancer among males and 70% among females is attributable to smoking and would be preventable by eliminating smoking.¹¹ Is it worthwhile to continue to invest resources in discovering and characterising occupational carcinogens? The answer is clearly affirmative. Not only are the complement of these percentages, 10% among males and more among females, important amounts, but the percentages attributable to occupation are not in any way constrained to these complements. It is not inconceivable that as much as 20% (or more) of lung cancer among males in industrialised countries may be preventable in the workplace.^{10, 12}

The dilemma is how to identify and characterise such hazards. Historically, the retrospective cohort study has been the design of choice, but this design was susceptible to various selection and confounding biases. The population-based case-control design had some advantages, but one critical disadvantage: much greater difficulty of valid exposure assessment. The expert-based exposure assessment of the type used by Carel *et al* was developed precisely to palliate this difficulty. It has been over 25 years since the approach was developed,^{13, 14} but it is not easy to assess whether it has been a success or not. It seems self-evident that

it is preferable to the method of exposure assessment that was previously used in population-based case-control studies, namely using job titles as the surrogate for exposure. But how much have we learned as a result of using this method is hard to ascertain. In one respect it has not succeeded; namely, there have not been many investigators who have taken up this approach. The reason is simple; it is a very costly approach. It requires training one or more experts in an activity in which they are not yet expert.

Creating experts takes time and there is not yet enough experience accumulated to transform the training into a simple set of rules. Worldwide there may be a dozen or so people who had conducted this type of activity before the IARC-based study in eastern Europe and the UK. This study has embodied the most ambitious effort yet to train a cadre of exposure assessment experts. The investigators might have decided to create a single unit with this type of expertise and to have that unit conduct the exposure assessment for all the centres. But they decided instead to rely on local resources and train an exposure assessor in each centre. This permits a greater access to and exploitation of knowledge of local conditions. And historic occupational exposure certainly has a local dimension that is hard to assess from a distance. The training that the experts underwent was intensive. The knowledge required to conduct the work—exposure patterns in all industries, all occupations, over decades of time—is impossible to impart quickly. The best that can be achieved is to impart the principles of exposure assessment and coding for epidemiological purposes, and to indicate the types of resources that might be accessed for the purpose. While this approach is difficult, costly and imperfect, it may be the only hope we have to conduct valid epidemiological research on occupational cancer. The number of retrospective cohort studies has been declining in developed countries. While the reasons are not clear-cut, they may well include the following: the traditional industrial blue-collar workforce has been declining in numbers; companies have become more “gun-shy” in reaction to proposed research on their workers; and the legal/ethics climate in some countries is threatening to make it impossible to study subjects who are not in a position to provide informed consent (as is obviously the case in retrospective cohort studies).

Occupational cancer remains a critically important area of research—both for lung cancer and for other cancers. It is important to have in place the resources needed to conduct such research. It may be that population-based case-control studies will be the prime design we can use; to the extent that this is true, we need to find a way to create and maintain a cadre of experts who can carry out the exposure assessment needed for such research.

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REFERENCES

- 1 IARC. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Volume 14. *Asbestos*. Lyon: IARC (International Agency for Research on Cancer), 1977.
- 2 Collegium Ramazzini. Call for an international ban on asbestos. *J Occup Environ Med* 1999;**41**:830–2.
- 3 Aguilar-Madrid G, Juarez-Perez CA, Markowitz S, *et al*. Globalization and the transfer of hazardous industry: asbestos in Mexico, 1979–2000. *Int J Occup Environ Health* 2003;**9**:272–9.
- 4 Dave SK, Beckett WS. Occupational asbestos exposure and predictable asbestos-related diseases in India. *Am J Ind Med* 2005;**48**:137–43.
- 5 Karjalainen A, Anttila S, Vanhala E, *et al*. Asbestos exposure and the risk of lung cancer in a general urban population. *Scand J Work Environ Health* 1994;**20**:243–50.
- 6 Yeung P, Rogers A. An occupation-industry matrix analysis of mesothelioma cases in Australia 1980–1985. *Appl Occup Environ Hyg* 2001;**16**:40–4.
- 7 Pan XL, Day HW, Wang W, *et al*. Residential proximity to naturally occurring asbestos and mesothelioma risk in California. *Am J Respir Crit Care Med* 2005;**172**:1019–25.
- 8 Hodgson J, Darnton A. The quantitative risks of mesothelioma and lung cancer in relation to asbestos exposure. *Ann Occup Hyg* 2000;**44**:565–601.
- 9 Henderson DW, Rodelsperger K, Weitowitz HJ, *et al*. After Helsinki: a multidisciplinary review of the relationship between asbestos exposure and lung cancer, with emphasis on studies published during 1997–2004. *Pathology* 2004;**36**:517–50.
- 10 Albin M, Magnani C, Krstev S, *et al*. Asbestos and cancer: an overview of current trends in Europe. *Environ Health Perspect* 1999;**107**(Suppl 2):289–98.
- 11 IARC. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 83. *Tobacco smoke and involuntary smoking*. Lyon: IARC (International Agency for Research on Cancer), 2004.
- 12 Steenland K, Burnett C, Lalich N, *et al*. Dying for work: the magnitude of US mortality from selected causes of death associated with occupation. *Am J Ind Med* 2003;**43**:461–82.
- 13 Siemiatycki J, Day NE, Fabry J, *et al*. Discovering carcinogens in the occupational environment: a novel epidemiologic approach. *J Natl Cancer Inst* 1981;**66**:217–25.
- 14 Siemiatycki J. Exposure assessment in community-based studies of occupational cancer. *Occup Hyg* 1996;**3**:41–58.