

## Mini-Symposium 1: Exposure Assessment in Epidemiological Studies of Cancer

### O2E.1 WHY THE QUALITY OF EXPOSURE ASSESSMENT MATTERS IN HUMAN OBSERVATIONAL STUDIES AND CONSEQUENT HAZARD AND RISK ASSESSMENT

Hans Kromhout\*. *Utrecht University, Utrecht, Netherlands*

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Occupational exposures can vary dramatically and therefore their assessment and assignment in epidemiological studies often come with considerable error. In prior eras of occupational epidemiology, exposure was treated as static; often in a binary (yes/no) or ordinal (no/low/medium/high) manner. In modern times the need for better quality exposure assessment and assignment is clear, particularly in situations where occupational exposures and outcomes are less convincingly associated. High quality exposure assessment is imperative for informative human observational studies that permit better hazard classifications and quantification of exposure response relationships.

A wide range of exposure assessment methods exist and have been applied; varying from self-reports general and specific job-exposure matrices, and case-by-case expert-based assessments to elaborate quantitative algorithms using the collective information of thousands of workplace measurements. The selection of method largely depends on the type of epidemiological study performed (retrospective versus prospective; case-control versus cohort; general population versus worker-based), the agent under consideration, and the extent of access to experts and measurement data. In addition, each method has its own specific limitations and possibilities, and will not be feasible for use in every study.

Formal methods to evaluate exposure assessment quality in epidemiological studies are largely non-existent, but recent work within the IARC Monographs Programme and elsewhere have provided a direction for a more systematic approach. Several systematic literature reviews of human observational studies have shown that incorporating the quality of exposure assessment can produce a more convincing and informative evaluation when reviewing a body of evidence.

As part of a mini-symposium on the importance of exposure assessment in epidemiology for hazard identification and risk characterization, this presentation will provide a brief introduction to exposure assessment and assignment for human observational studies, as well as directions for a more formal approach to their evaluation.

### O2E.2 FROM HIGH-DOSE OCCUPATIONAL TO LOW-DOSE RESIDENTIAL EXPOSURES IN RADON EPIDEMIOLOGY: HOW HIGH-QUALITY EXPOSURE ASSESSMENT TIES IT ALL TOGETHER

Mary Schubauer-Berigan\*. *International Agency for Research on Cancer, Lyon, France*

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Since the 1950s, formal epidemiologic investigations among uranium miners have yielded valuable information about lung cancer hazard from exposure to radon progeny. Early cohort

studies used thousands of measurements of radon progeny in mines and a job-exposure matrix approach to assign dose estimates to miners. Over time, exposure estimation in uranium and other underground mines has become increasingly refined, making possible 25 years ago a landmark pooled study that permitted quantitative risk characterization across 11 populations of miners. More recently, case-control studies of residential radon exposure have been conducted and pooled in Europe and North America, with exposure estimation generally based on long-term, modern radon progeny measurements in the homes where subjects resided. Other research has contributed importantly to methods development related to quantifying the impact of errors in dose estimation on risk characterization. This presentation, part of a mini-symposium on the importance of exposure assessment in epidemiology for hazard identification and risk characterization, will emphasize how high quality exposure assessment methodology (and attendant uncertainties) provides the linchpin that connects these landmark studies of occupational and environmental exposure across orders of magnitude of dose.

### O2E.3 EVALUATION OF THE EXPOSURE ASSESSMENT METHODS USED IN BENZENE EPIDEMIOLOGY

Deborah C Glass\*. *Monash University, Melbourne, Australia*

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A variety of exposure assessment methods have been used in epidemiological studies of benzene-exposed workers. The most usual metrics are duration, mean daily exposure intensity (ppm) and ppm-years (intensity multiplied by duration and summed over the exposure period).

Many of the early studies were of cancer and mortality in petroleum industry workers. These studies compared the cancer rates of the workers with those of the general population. Benzene was known to be present at such facilities but benzene exposure estimates were not provided.

In some papers, the cancer risk was compared between exposed and unexposed workers in the same industry or facility. Other papers compared the cancer risk for workers categorised into Low, Medium and High exposure groups, this categorisation may have drawn on measured exposure data. The categorisation may have used a general population or an industry-specific job-exposure matrix (JEM). The latter being likely to be more precise.

The strongest exposure estimates were those where benzene exposure estimates were attributed by experts to individual job titles/areas of work based on measured data, from an appropriate time frame. The exposure attribution was normally done case-blind for case-control studies to avoid bias. Exposure modifiers may have been used to extrapolate data to jobs and eras where measurements were not available. In particular personal benzene exposure data were not usually available before 1980, so extrapolations back in time were needed. In some cases hydrocarbon measurements have been used as a surrogate for benzene measurements. Validation of exposure estimates can add to confidence in the estimates.

In a few studies, biological exposure data was used to attribute exposure estimates to work. Where the data are from the individual concerned rather than attributed on a group basis, the exposure assessment is considered more robust.