Carcinogenicity of benzene

In October, 2017, a Working Group of 27 scientists from 13 countries met at the International Agency for Research on Cancer (IARC) in Lyon, France, to finalise their evaluation of the carcinogenicity of benzene. This assessment will be published in Volume 120 of the IARC Monographs.¹

Benzene, an aromatic hydrocarbon, is a ubiquitous air pollutant, arising mostly from anthropogenic sources, notably combustion. It is a component of gasoline, vehicle exhaust, industrial emissions, and tobacco smoke, and was used historically as a solvent in industry and consumer products. The uses of benzene as a solvent are now restricted in many countries, but it is still produced in high volumes for use primarily as a chemical intermediate.

Occupational exposure to benzene can occur in diverse industries, including petroleum, chemical production, and manufacturing, and in some countries still occurs in industries where high levels were observed historically, such as shoemaking, painting, printing, and rubber manufacturing. The population at large can be exposed to benzene in polluted air and water and through the use of benzene-containing products. Benzene concentrations in workplace and outdoor air have declined over time; the Working Group noted concentrations less than 3·00 and 0·005 mg/m³ in workplace and outdoor air have declined over time; the Working Group noted concentrations less than 3·00 and 0·005 mg/m³ in workplace and outdoor air have declined over time; the Working Group noted concentrations less than 3·00 and 0·005 mg/m³ in workplace and outdoor air have declined over time; the Working Group noted concentrations less than 3·00 and 0·005 mg/m³ in workplace and outdoor air have declined over time; the Working Group noted concentrations less than 3·00 and 0·005 mg/m³ in workplace and outdoor air have declined over time; the Working Group noted concentrations less than 3·00 and 0·005 mg/m³ in workplace and outdoor air have declined over time.

New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴ New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴ New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴ New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴ New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴ New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴ New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴ New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴ New data were also available from several recent studies that showed positive associations between AML in children and environmental exposure to benzene.¹⁴
of reactive electrophiles via multiple metabolic pathways in various tissues, including bone marrow. It exhibits many of the key characteristics of carcinogens. In particular, strong metabolic pathways in various tissues, of reactive electrophiles via multiple modulates receptor-mediated effects relevant to aryl hydrocarbon receptor, and induces apoptosis.

In benzene-exposed humans, epoxide-protein and benzoquinone-protein adducts are formed in blood. Additionally, benzene induces oxidative stress in exposed humans, human cells, and mouse bone marrow. In studies of occupationally exposed humans, benzene induces oxidative DNA damage, DNA strand breaks, gene mutations, chromosomal aberrations, and micronuclei. Specific cytogenetic changes induced in exposed humans include aneuploidy, translocations, and various other structural chromosome changes. In the bone marrow of experimental animals exposed in vivo, benzene induces DNA adducts, chromosomal aberrations, and micronuclei. Similarly, in human cells in vitro, benzene or its metabolites induce DNA adducts, DNA damage, and chromosomal aberrations.

Many studies in exposed humans have demonstrated haematotoxicity, ranging from decreased white blood cell counts at lower exposures to aplastic anaemia and pancytopenia at higher exposures. Benzene-induced haematotoxicity is associated with future risk of developing haematological malignancy or related disorders. Although no human studies of benzene exposure directly examined changes in immune function, multiple experimental animal studies demonstrate haematotoxicity and consistent immunosuppressive effects on humoral and cell-mediated functional assays.

The Working Group investigated the shape and slope of the exposure–response function for AML in metaregression analyses of six published occupational cohort studies with suitable data. The relationship of benzene exposure with the log relative-risk was well described by a linear model. The slope was moderately sensitive to whether a cohort study of rubber hydrochloride workers, which had the highest exposure estimates, was included in the model. In the majority of human studies that reported exposure–response information for benzene and endpoints relevant to the key characteristics of carcinogens (ie, micronuclei, chromosomal aberrations, and leukocyte counts), an exposure–response gradient was reported.

We declare no competing interests.

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Declaration of interests: RHA reports expenses from the American Beverage Association. PJR reports employment by Shell International BV, is a member of the Dutch Health Council, serving on the Dutch Expert Committee on occupation safety and the committee for the evacuation of carcinogenic substances, and is a member of the scientific committee on occupational exposure levels of the European Commission. SH was paid by the American Petroleum Institute. PJR declares testimony in product liability cases. All other observers declare no competing interests.

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For IARC declarations of interests see http://monographs.iarc.fr/ENG/ Meetings/vol120-participants.pdf