SILICA:
CRYSTALLINE SILICA (Group 2A)
AMORPHOUS SILICA (Group 3)

A. Evidence for carcinogenicity to humans (*limited* for crystalline silica; *inadequate* for amorphous silica)

A number of studies have shown that persons diagnosed as having silicosis after occupational exposure to dust containing crystalline silica have an increased risk for dying from lung cancer[1,2]. This increase has been seen among miners, quarry workers, foundry workers, ceramic workers, granite workers and stone cutters.

Workers in the granite industry have shown increased risks for lung cancer in some studies; the excesses were of the order of 10-30% and were not usually statistically significant[1]. An extended follow-up of Finnish granite workers showed 22 lung cancer cases, with 17.1 expected. When allowing for a latency of 15 years, 21 cases were observed, whereas nine were expected ($p < 0.01$; Poisson distribution). Smoking habits were similar to those of the active Finnish male population, and exposures to radon and asbestos were considered unlikely to have occurred[3]. A recent joint Nordic register linkage study, combining lung cancer mortality and incidence data from the cancer registries with census-based records on previous occupation of 20-64-year-old males, showed an elevated risk of lung cancer among stone cutters in Finland and Denmark, but not in Sweden or Norway. Excess risk was also seen for Finnish males in excavation work, whereas no such risk was evident in the other countries[4].

Three epidemiological studies of workers in the ceramics, glass and refractory brick industries, using different designs, have shown a roughly two-fold increase in mortality from lung cancer. Only one case-referent study took smoking into account[1]. The Nordic register study also found an excess of lung cancer for Danish glass-workers, but workers in the ceramics industry did not have an elevated risk in any of the countries[4]. A US cohort study of pottery workers exposed to silica and talc showed a nonsignificant standardized mortality ratio of 137 for workers exposed to high levels of silica dust with no talc exposure[5].

Several studies of metal miners have shown mortality rates from lung cancer some 20-50% higher than expected[1]. In the Nordic register study[4], relative risks from 1.0 (Norwegian metal miners) to 5.0 (Finnish nonferrous ore miners) were seen. The largest group was Swedish iron ore miners; their relative risk was 3.2 (95% confidence interval, 2.9-3.5), based on 124 observed cases. However, in repeated cohort studies of workers in a

gold mine, no excess lung cancer risk was seen[1,6]. The contribution of radon has not in general been assessed.

Coal miners appear not to be at increased risk of lung cancer[1].

Studies of foundry workers (see p. 224) have consistently shown moderate increases in mortality from lung cancer[1,7]. The Nordic register study also showed lung cancer risk to be elevated for foundry workers in all Nordic countries[4]. However, several contaminants other than silica dust occur in the foundry environment, including polycyclic aromatic hydrocarbons.

Epidemiological studies of both exposed populations and silicotics give indications of the carcinogenicity of a working environment contaminated with crystalline silica, particularly in combination with other exposures. In most industries studied, such an effect cannot be separated from those of other concomitant carcinogenic exposures, but in the granite and stone industry the exposure to silica is fairly pure. Few studies provide data on smoking. It is not clear whether the mechanisms of a possible carcinogenic effect of crystalline silica requires a fibrotic process.

No adequate epidemiological study or case report was available to evaluate the carcinogenicity of amorphous silica to humans.

B. Evidence for carcinogenicity to animals (*sufficient* for crystalline silica; *inadequate* for amorphous silica)

Various forms and preparations of crystalline silica produced adenocarcinomas and squamous-cell carcinomas of the lung in rats after inhalation or repeated intratracheal instillation. Thoracic and abdominal malignant lymphomas developed in rats after single intrapleural and intraperitoneal injections of suspensions of several types of quartz. Malignant lymphomas developed after intrapleural injection of cristobalite and tridymite. No tumorigenic response was observed in hamsters after repeated intratracheal instillation of quartz dusts or in a mouse-lung adenoma assay with one sample of quartz[1].

Tests of different preparations of amorphous silica administered by various routes to mice and rats either gave negative results or were inadequate. In two limited tests (one by intraperitoneal injection and one by inhalation) in mice, increased incidences of lymphosarcomas in the abdominal cavity and of lung tumours, respectively, were observed[1].

C. Other relevant data

No data were available on the genetic and related effects of silica in humans.

Quartz did not induce micronuclei in mice treated *in vivo*. In Syrian hamster embryo cells *in vitro*, it induced cell transformation and micronuclei; it did not induce sister chromatid exchanges in Chinese hamster cells. Quartz did not inhibit intercellular communication in Chinese hamster cells *in vitro*. Silica was not mutagenic to bacteria[8].

References

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