

A ban on asbestos must be based on a comparative risk assessment

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In this issue (page 489), Joseph LaDou and colleagues on behalf of the Collegium Ramazzini¹ call for an immediate and total ban on “asbestos” products because the current health risks associated with the use of “asbestos” are not acceptable, “controlled use” is not possible and “safer” substitutes are readily available. The logic is indisputable, but the premises are not. First, the risks associated with chrysotile, the type of asbestos used nowadays, are exaggerated by relying on a single and aberrant study. Second, the statements on controlled use and substitutes are supported neither by evidence nor by references. Finally, the Collegium fails to consider the technical efficiency of chrysotile and its substitutes when used in brakes and thermal insulation. A distortion of the evidence might result in a useless ban and possibly increased risk. This commentary presents critical evidence omitted by the Collegium and argues that any decision to ban “asbestos” should rely on a comparative risk assessment of chrysotile and its substitutes.

Which asbestos products are at stake specifically? “Asbestos” is a group of heterogeneous mineral fibres that have some common physical characteristics and commercial uses. The risk of developing asbestos-related diseases depends on the dose, dimensions, durability (biopersistence) and surface reactivity of inhaled materials. The greatest differences in the physicochemical properties are between curly *chrysotile* and the more biopersistent needle-like *amphiboles* (tremolite, amosite and crocidolite). These differences entail different industrial applications and different toxicities. For instance, amphibole fibres were heavily used in buildings, blast furnaces and ships until 1980 in Europe because they resist high temperatures and chemically aggressive environments better than chrysotile. These uses and the 25–50-year latency of mesothelioma are responsible for mesothelioma clusters in ship-building areas around the world and for the predicted peak of the mesothelioma epidemic at around 2020 in Europe.² The much lower incidence of mesothelioma in chrysotile industries (mining, cement, textiles and friction products) probably results from the much shorter biopersistence and lower iron content of chrysotile.^{3,4} Yet, an “asbestos” ban will only replace short, and thus less toxic, chrysotile fibres with certain substitute materials in new high-density cement and friction products, or it will replace fibre-containing products with other

products altogether (e.g., steel, polyvinyl chloride [PVC]). It will not address the main cause of the mesothelioma epidemic: extant friable products in buildings that contain amphibole fibres.

What risks are associated with chrysotile fibres? The Collegium claims that all asbestos fibres are associated with similar risks of lung cancer and asbestosis, and only marginally different risks of mesothelioma. Experienced scientists in the field strongly disagree with this view.^{5–8} Risk assessments and reviews generally attribute peritoneal mesotheliomas exclusively to amphibole fibres. The 47 cohorts of individuals working with asbestos reviewed in the most recent and comprehensive risk assessments^{9,10} show higher risks in those working with amphibole than in those working with chrysotile. Thus, excess lung cancers occur 3 times, pleural mesothelioma 12 times and peritoneal mesotheliomas 30 times more frequently in mainly amphibole than in chrysotile industries for an equal number of expected cases (see [additional data in the Table](#) on the *CMAJ* Web site at www.cma.ca/cmaj/vol-164/issue-4.htm). Exposure–response comparisons of studies with meaningful exposure data suggest that chrysotile workers were 4–24 times less at risk of asbestos-induced lung cancer than amphibole workers at equal exposure.^{11,12} To put this in perspective, based on the exposure–response estimate of the US Environmental Protection Agency (EPA), the lifetime risk of an asbestos-induced lung cancer in smoking male workers exposed for 20 years to 20 fibres per millilitre of air in primarily chrysotile industries was about 2%–10%, compared with 40% in smoking male workers in industries using amphiboles. Risk in nonsmoking asbestos workers was about 15 times lower in both cases.

The mining and milling industry is most informative because fibre types are not mixed, and because it produces fibres of different sizes for all the asbestos industries. Of all the pleural mesotheliomas reported among chrysotile workers, 70% occurred among Quebec miners and millers, and most were traced to coexposures to amphiboles.¹³ The dose-specific risks of asbestosis,^{14,15} lung cancer and mesothelioma are 15–50 times lower in chrysotile miners than in amphibole miners.^{14,15} This seems true also for nonoccupationally exposed populations.^{16–18} In contrast to the Collegium’s interpretation of our research, my colleagues and I found that the absence of excess lung cancers among residents of

chrysotile mining towns implies a risk at least 15 times smaller than that predicted with the EPA model,¹⁷ and the number of mesotheliomas observed is at least 20 times smaller than that predicted by the EPA model.¹⁹

The Collegium discarded previous risk assessments and estimated risk from a *single cohort* of chrysotile textile workers.^{20,21} Yet this cohort may well be an unrepresentative outlier.²² The ratio of excess lung cancers to mesotheliomas is 3–10 times larger than in other asbestos studies. These workers were exposed to long amphibole fibres²³ and to mineral oils. Moreover, rarely is anyone exposed to asbestos textile fibres today. On that precarious basis, the Collegium estimated 10 times the risk for chrysotile than that of any previous risk assessment, yet the latter assessments were based on 30%-amphibole exposures and were construed to overestimate the risks of chrysotile according to the EPA.²⁴

Controlled occupational exposures today are about 1000 times lower than in the past.²⁵ Accordingly, *lifetime risks* of asbestos-related deaths in today's chrysotile-exposed workers should be at least 1000 times lower than in individuals who worked with an "asbestos mixture" in the past, or less than 1–5 per 100 000 lives, that is, 20–100 times less than the Collegium's estimate. Such risks are comparable to or lower than risks accepted by the US National Institute for Occupational Safety and Health in the workplace. Risk estimates based only on chrysotile friction products and cement industries may be lower still.²⁶

Are substitutes definitely "safer?" Chrysotile substitutes comprise p-aramid, polyvinyl alcohol (PVA), cellulose, polyacrylonitrile, glass fibres, graphite, polytetrafluoroethylene, ceramic fibres and silicon carbide whiskers. Epidemiological evidence concerning these substitutes is scarce, and the cohorts studied have been much less exposed than were asbestos workers in the past. Moreover, much lower exposures and doses are used in today's experiments on synthetic fibres and other substitutes than in past experiments on asbestos fibres.²⁷ So, apparent differences cannot be taken at face value.

There are reasons to doubt the safety of substitutes for chrysotile. Glass and ceramic fibres, silicon carbide whiskers, and rock and slag wools have been classified by the International Agency for Research on Cancer as possible or probable carcinogens. Any fibre can carry chemical and biological contaminants such as cigarette tars deeply into the lung by adsorption. The lung cancer and fibrosis health risks of asbestos substitutes depend on the dose, dimensions, biopersistence and surface reactivity, as is the case for asbestos fibres, but they also depend on dissolution by-products.²⁷ PVA and p-aramid (Kevlar) fibres are less respirable but more biopersistent than chrysotile, and p-aramid fibres have induced fibrosis and mesothelioma in inoculation studies.²⁸ The biopersistence of cellulose exceeds that of chrysotile,²⁹ cytotoxic effects have been observed³⁰ and an epidemiological study has found chronic airflow limitations.³¹ Refractory ceramic fibres that complement p-aramid materials in brake pads may be more carcinogenic

than chrysotile,^{32,33} although one experiment failed to replicate these findings.³⁴ All man-made fibres are carcinogenic when inoculated into the peritoneum. One review concluded that they are at least as carcinogenic as "asbestos" fibres when inhaled.³⁵ Another concluded that "synthetic vitreous fibres are not appreciably worse, fibre for fibre, than chrysotile," although mechanistic considerations suggest that glass wool might be "5 times less carcinogenic."³⁶

Although the results of earlier US and European epidemiological studies were negative or not conclusive for lung cancer, a recent European cohort study found a dose-related excess of oral, pharyngeal and laryngeal cancers for individuals working with rock and slag wool (relative risk [RR] 1.5, 95% confidence interval [CI] 1.0–2.1) and a similar, but not statistically significant, relationship for those working with glass wool (RR 1.4, 95% CI 0.8–2.3).³⁷ A contemporary German case-control study found an excess risk of lung cancer (odds ratio 1.5, 95% CI 1.2–1.9) among vitreous fibre insulators after controlling for smoking and asbestos exposure.³⁸

Finally, the most comprehensive and recent review²⁷ of human and animal data on man-made mineral fibres concludes that ceramic fibres, rock and slag wools are "probably" and glass wool is "possibly" carcinogenic, whereas the health effects of other man-made substitutes cannot be evaluated at the present time. The Institut National de la Santé et de la Recherche Médicale (INSERM) in France deplores²⁷ the fact that man-made fibres have been tested without the dust-suppressing agents and binders normally added in the industrial process, and that experiments are now conducted at much lower doses than those used in past studies of asbestos fibres: they state that similar doses in carcinogenic assays of asbestos fibres would likely have resulted in absent or nonsignificant health effects. Finally, INSERM underlines that end points other than cancer such as lung irritation, fibroses and dermatoses have not been adequately considered and that the dissolution by-products of chrysotile substitutes can reach distant organs.

Are substitutes as efficient as chrysotile in safety applications? Some important product safety issues have been raised by ancillary sources. Asbestos-cement pipes are being replaced by PVC and ductile steel pipes. Yet, as mentioned in the 1991 ruling that overturned the EPA's asbestos ban, "The EPA agency concedes the population cancer risk for production of ductile iron pipe could be comparable to the population cancer risk for production of A/C pipe."³⁹ Apparently, PVC pipe systems in buildings can spread flames from floor to floor and can release hydrogen chloride gas, dioxin and other organochlorines in the case of a fire.⁴⁰ Concerning brakes, the head of the Society of Automotive Engineers' Brake Committee stated, "P-aramid, glass fiber and several glass-like fibers have substantially higher friction wet than dry and provide less dimensional stability to friction materials, especially large drum brake lining segments."⁴¹ According to this engineer, substitute products have been responsible for brake problems with General Motors X-body cars and for the fracturing of thousands of

heavy-truck brake drums each year. Asbestos brakes are now installed again in US luxury cars to lower insurance expenses.⁴¹ Substitutes may be more efficient in other safety applications, however, the performance risks of asbestos substitutes are poorly documented. Such safety issues cannot simply be ignored and should be addressed in a proper risk assessment of the substitutes for chrysotile.

Under what exposure conditions are substitutes safer? Although INSERM insists that exposure to asbestos substitutes should be kept as low as possible, the Collegium does not caution against such exposures and communicates a false sense of security that might result in higher exposure to substitutes than to chrysotile. Today's health standards tolerate 5–20 times more exposure to glass, rock and slag wools than to chrysotile fibres. If those standards were applied after an asbestos ban, the substitutes would have to be more than 5–20 times less toxic than chrysotile to reduce risk. If substitutes are less hazardous than chrysotile by an unknown factor, then the same exposure limits and standards should apply to substitutes as to chrysotile. Indeed, even present exposures to substitutes could entail greater health risks than chrysotile exposures.

Likewise, the critical problem of poorly controlled environments (e.g., developing countries) underlined by the Collegium cannot be solved by substitution alone. In addition to the risks of substitute materials, coexposures to carcinogens contained in asbestos products (e.g., respirable quartz) entail health risks; such exposures must be minimized by education and by enforcing laws and regulations. A ban is not a sufficient solution and product users must be warned about the need to apply similar safety controls and procedures to asbestos and its substitutes. The *conditions* of a ban are critical.

Over the last 20 years, risk assessment methods have been developed for regulating or recommending exposure standards. In this context, the uncertainties, inconsistencies and gaps in knowledge in risk assessments have been dealt with by the *precautionary principle*, namely, by making assumptions and choosing models that tend to overestimate risks. In this case, to ban is to substitute and one must apply the precautionary principle equally to chrysotile and to its substitutes. This *comparative risk* approach differs from traditional risk assessment. The Collegium applies the precautionary principle to chrysotile but not to its substitutes, with the result that the proposed ban could do more harm than good.

Other aspects not considered here involve the costs of sanitation piping to developing nations and the transfer of jobs from poor asbestos-producing countries to affluent nations producing substitutes. The Collegium's call to ban asbestos is insufficient in all respects. A ban must be assessed more thoughtfully following a comparative risk approach before being adopted. The progressive introduction of safe, efficient substitutes should proceed apace but with evidence-based safety assurance, in concordance with the precautionary principle.

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