Carcinogenicity of asbestos: Convincing evidence, conflicting interests

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ABSTRACT

In spite of hard epidemiological and clinical evidence associating asbestos fibre with asbestosis and cancer, the issue is controversial and likely to remain so. The focus is now shifting to non-occupational exposure, differential risk to various asbestos fibre types and the relatively low level of carcinogenicity of the chrysotile form. This creates further space for scientific debate and the opportunity to form a considered opinion. However, the situation may take a worrisome turn if some of these scientific inquiries are used by market forces to their advantage.

A look at the history of corporate activities in asbestos-related research reveals a disturbing trend. Information that was made available, through legal interventions, clearly shows how for half a century the asbestos industry in collaboration with some academic leaders of occupational medicine successfully suppressed evidence against asbestos.

In developing countries, extensive and aggressive marketing continues by chrysotile producers, mainly Canadian companies. There is renewed pressure on this part of the world since new use of asbestos has been almost completely discontinued in the developed countries as a result of public pressure and state prohibitions.

In this scenario, relaxation of public health control over any form of asbestos should be opposed. It is extremely dangerous and scientifically untenable to say that chrysotile asbestos can be used without risk. It has been identified as a potent human carcinogen, and remains so. However, some restraint must be exercised while dealing with asbestos that has already been released into the environment. Disturbing it unnecessarily may cause more harm than good.

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INTRODUCTION

The industrial revolution brought with it many unwanted consequences. The release of several pollutants in the environment made the human population vulnerable to occupational and non-occupational exposures. Though it has happened across the globe, the burden of industrial pollutants has been more pronounced in developing countries. The reasons behind such a situation are complex, but weak politics, science and legislation, crippled further by half-hearted enforcement in contrast to a strong and defiant corporate, are some factors that can be distinctly identified.

Partly for scientific reasons and partly due to the interests of market forces, the basis and level of carcinogenicity of fibrous minerals has been a matter of controversy throughout the last century. An important group of fibrous minerals is known by the generic term asbestos. There are four commercially important forms: chrysotile, crocidolite, amosite and anthophyllite. Of them, chrysotile alone accounts for 95% of global asbestos production and most of it comes from the province of Quebec, Canada.\(^1\)

Chrysotile is a fibrous hydrated magnesium silicate mineral used in many commercial products. There are several accompanying minerals in the fibrous ores, and fibrous amphibole may be among them. In this regard, tremolite is thought to be especially important.\(^2\)

CHrysOTile: THE BACKGROUND

Low concentrations of chrysotile are found throughout the earth's global crust (air, water, ice caps and soil) but human activities contributing to fibre aerosolization and distribution in the environment are chiefly occupational, e.g. recovery from geological deposits, processing, manufacture of products containing asbestos and their disposal. The asbestos cement industry is the largest user (85% of total use) of chrysotile fibre.\(^2\)

Today, we have sufficient epidemiological and clinical evidence that besides causing a progressive fibrotic disease of the lung called asbestosis, asbestos also causes cancer of the lung, malignant mesothelioma of the pleura and peritoneum, cancer of the larynx and some gastrointestinal cancers. The nature and amount of evidence goes beyond any scientific controversy and in acknowledgment of this body of evidence,\(^3,4\) the Environmental Protection Agency (EPA) and the World Health Organization's International Agency for Research on Cancer (IARC) have declared asbestos a proven human carcinogen.\(^1,5\) When doubts were raised about declaring all forms of asbestos as carcinogenic and it was suggested that some type of asbestos might not cause cancer, the issue was carefully considered by the scientific community.

In the light of hard scientific evidence, IARC-WHO acknowledged that all forms of asbestos are known carcinogens. Epidemiological, clinical and laboratory studies have shown that it is fully capable of causing lung cancer, mesothelioma and a whole range of asbestos-related diseases.\(^5\) These developments resulted in mounting public pressure culminating in government bans on the further release of asbestos into the environment in developed countries. New use of asbestos has almost completely ended in the developed world. In contrast to this, extensive and aggressive
marketing by Canada and other exporting nations continues in the developing world, where sales remain strong.8

Recent publications on exposure to chrysotile asbestos7-11 have generated new curiosity. Consequent to the newer knowledge about the chrysotile form and a significant decline in high-dose asbestos exposure, at least in the developed world, the focus of research and public health debate is now shifting towards the supposedly low level of carcinogenicity of a particular type of asbestos and the effect of non-occupational low-dose exposure to it on human health. This shift creates a space for further understanding this area of environmental safety, which is full of unresolved questions. However, the situation may take a worrisome turn when some of these scientific inquiries are used by the industry to its advantage. The lure of sales may prompt corporate forces to turn this plain scientific curiosity into profitable confusion.

NEWER DEVELOPMENTS

An important debate continues on the basis of the carcinogenicity caused by asbestos. Data on human subjects are chiefly clinico-epidemiological, supported by radiological and pathological evidence. Information that may clinch the issue is coming mainly from laboratory mammals and in vitro studies. The interpretation of data coming from animal models and its relevance to humans is also highly contested. However, studies on cells, genotoxicity and interactions with DNA have provided a closer view of asbestos-induced pathogenesis. The interactions of chrysotile fibres with the DNA of mammalian cells may result in chromosomal or mutational events that can initiate carcinogenesis or genetic damage associated with cytolysis.12 The definitive mechanisms, initiated and sustained by chrysotile exposure, which actually cause cell proliferation, remain unexplored. The relevance of various routes of exposure in experimental animals to risk assessment in humans has also generated controversy.

The problem with this multifaceted debate is that most of the participants derive their motivation from a highly focused context, instead of taking a holistic approach towards the issue. This often reduces the sublime to the simplistic and, in turn, provides fuel to public health and regulatory controversies. Through a series of original research articles, McDonald et al., Liddell, et al.,10 and McDonald et al.,9 have proposed that:
1. Chrysotile asbestos, at least in the pure form, has minimum, if any, potential to cause mesothelioma.
2. The overall carcinogenicity of chrysotile is much lower than that of amphiboles.

The scientific basis behind the EPA’s recommendations has also been challenged. Camus et al.,11 have suggested that the dose-response relationship between asbestos and lung cancer may be less steep at low doses than is assumed in the EPA’s model. While asserting that the EPA’s model overestimates the risk of asbestos-induced lung cancer in a study population by at least a factor of ten, they also suggest that there may exist a threshold level of exposure to asbestos below which no carcinogenicity is seen.

Some of these findings are being considered as a shot in the arm of the beleaguered asbestos industry but they have also generated a wider scientific discourse. Efforts have been made by the international health community to form a considered opinion and settle the issues either revived or created by the new information. This collective opinion has been suitably represented by a very articulate editorial13 and a succinct commentary14 that appeared in two of the leading multidisciplinary biomedical journals. The commentary in the Lancet,14 after considering the conclusions made by McDonald et al., Liddell et al.,10 and McDonald et al.,9 says that serious discrepancies in the data, experimental as well as observational, preclude ready acceptance of these conclusions. The commentary also counters the authors’ suggestion that chrysotile could be commercially used with very little health risk, by saying that chrysotile asbestos found in nature is typically contaminated with amphibole and the highly carcinogenic tremolite.

As for lung cancer, the basis of the assertions regarding the safety of chrysotile is precarious. Though these fibres are not commonly found in large quantities at necropsy as they are rapidly cleared from the human lung, their carcinogenicity in animal models is well established.15

The editorial in the N Engl J Med13 quotes the landmark research of Selikoff et al.,3,4 to prove the point that Canadian chrysotile, like all other forms of asbestos, is a potent human carcinogen. It also highlights the fact that one of the findings published by Camus et al.,11 (more than 7-fold mortality from pleural cancer in a mining area), corroborates the conclusions of Selikoff et al. In fact, the amount of chrysotile asbestos already released into the environment creates a situation where exposure to chrysotile products remains the leading cause of mesothelioma in the world.16

Landrigan13 carefully considers the challenge to the EPA’s model from Camus et al.,11 and states that the suggestions of Camus et al. are interesting but entirely speculative. They go beyond their data when they assert without qualification that the EPA’s model overestimates the cancer risk in non-occupational exposure. The editorial concludes by re-emphasizing that chrysotile asbestos is still indisputably a human carcinogen.

THE SILENCE THAT LASTED FOR HALF A CENTURY

All these developments could have been a part of a healthy scientific debate, but the past record of corporate interests and activities in such matters has added another angle that needs attention. The release of information on carcinogenicity of asbestos which had previously been suppressed by the industry17 has raised several questions about the credibility of biomedical research that is sponsored or indirectly promoted by market forces.

To gain insight into corporate activities regarding the identification of occupational carcinogens in the last century, Lilienfeld reviewed the actions of the asbestos industry. He collected all the relevant correspondence, confidential reports, and even exhibits used as evidence in several legal proceedings and cited them as references along with academic documents in his case study.18 He found that the industry, in concert with many of its collaborators, first generated data on the carcinogenicity of asbestos. When this data was found to be unfavourable, the industry systematically suppressed it for five decades. The issue of a warning to those exposed to asbestos was deliberately delayed. As a result, millions of workers were exposed to the carcinogen and hundreds of thousands died. Finally, the industry was forced to produce confidential documents containing research data. The information became public because of legal actions and not because of interventions by the scientific community. More disturbing was the fact that members of the academic medical community, in collusion with the insurance industry, participated in this exercise in deception. Some of them were leaders in the field of occupational medicine. The surprised author of the above-quoted study further states: ‘The degree to which scientific fraud permeated published reports is also of concern. . . . However, unemployment or withdrawal of research support may be the ultimate “reward” for
those who do not participate in such activities.' A run-down of the events revealed during the investigation unfolds the powerful role of the industry and its major actors in scientific establishments in dealing with matters related to market interests and people's health:

1. In the early 1900s, academic leadership in occupational medicine began to emerge. Dr Anthony Joseph Lanza established himself as an expert on pneumoconiosis.

2. In the wake of a legal challenge from workers, the mining industry started questioning the diagnosis of dust-induced pulmonary diseases. In 1920, Lanza left the Public Health Service and was hired by corporate agencies.

3. Until late 1934, the efforts of the industry were directed at keeping the research findings confidential. A key actor in these activities was Dr Lanza, an employee of Metropolitan Life Insurance Co. (MLIC). In 1933, Saranac Laboratory released some confidential data that led to the publication of a report on asbestosis and tuberculosis which was unfavourable to the industry. Lanza pulled up the Saranac Laboratory for this unauthorized release.

4. Outright deception by the industry began in 1934. Private promoters of research on asbestos began asserting that the results obtained would be considered their property and they would determine the extent and manner in which they should be published.

5. After his retirement from MLIC in 1948, Lanza founded the Institute of Industrial Medicine at New York University, built up a team and kept his connections with the corporate world alive.

6. The Industrial Commission of Illinois promulgated a rule that substances harmful to employees' health should be duly labelled. Asbestos companies were asked by their legal advisors to comply. For unknown reasons, the warning label was not added to the bags containing asbestos for another 13 years.

7. Dr A. J. Vorwald, the successor of Gardener and his colleagues, attempted to further investigate the asbestos–cancer relationship. After ending his tenure at Saranac Laboratory, he sought employment as a professor at an institution in California. Lanza flew to California to prevent this. The expenses of the trip were allegedly paid by MLIC. Dr W. Smith also met with a similar fate after he indicated an interest similar to that of Vorwald's.

8. By the early 1960s, the industry and its associates succeeded in suppressing much of the information on asbestos and cancer generated during the past two decades. In 1963, K. Smith, the medical director of a Canadian company, suggested the purchase of a shredding machine to 'thoroughly destroy' all copies of confidential correspondence in this regard.

9. During the same period, a parallel stream of academic scientists and physicians such as Selikoff and Wagner, kept publishing their data establishing the relationship between asbestos and malignancies.

10. In the mid-1960s, the asbestos industry began to place warnings on bags and on wooden crates containing their products. However, a series of confidential memos issued by asbestos companies during the same period clearly stated that for products exported from the USA, the warning on the bags should be covered and that on the crates, sanded off.

11. By the late 1970s, the industry was under attack in the press and courts. Members of Congress started calling representatives of industry 'liars'. Legal proceedings that followed made many confidential documents public. However, the story still remains patchy and incomplete.

HOW DO WE SUM IT UP?
The case study by Lilienfeld documented how a series of concerted actions to suppress unfavourable data were planned and carried out for half a century. Some of the principal actors in these activities were also leaders in occupational medicine. What should worry the scientific community more is the fact that such unfortunate happenings are not confined to the asbestos industry alone. A similar history has been documented in the aniline dye industry as well. Despite the disclosures of suppression and fraud, no mechanisms have been developed to prevent recurrences. People continue to live with the possibility of similar public health disasters.

Coming back to chrysotile, the empirical evidence is itself sufficient to argue against any relaxation of public health control over any type of asbestos. Recent efforts to portray chrysotile asbestos as safe are inaccurate. The assertions that chrysotile asbestos can be used without risk are contrary to fact and dangerous. The WHO Environmental Health Criteria 203 concludes by stating that exposure to chrysotile asbestos poses increased risk for asbestosis, lung cancer and mesothelioma in a dose-dependent manner. Though the question of threshold has been raised by some researchers, the criteria say that no threshold has been identified for carcinogenic risks.

On the positive side, it is getting clearer that the most dire predictions about an epidemic caused by non-occupational exposure to chrysotile have shown little evidence of materializing. The risk is not nil, but low. Scientific inquiry must proceed but as long as safer substitutes exist for most asbestos products, the proposition of releasing more asbestos into the environment or of relaxing pressure on the industry will be disastrous.

TREAD WITH CAUTION!
Cessation of further release of asbestos in the environment is one important goal to be accomplished. However, studied restraint is needed while dealing with the asbestos that remains as a legacy of past construction practices in millions of schools, homes and commercial buildings. It needs to be borne in mind that manipulation of friable asbestos products may be an important source of chrysotile emission into the environment.

Mistakes have been made in the past while handling the asbestos already used in buildings. Agitated parents in some communities have caused great harm to their children, school staff and themselves by tearing out asbestos sheets from school buildings without proper safety cover. In view of this, a rational set of legally enforceable controls was evolved in the USA under the Asbestos Hazard Emergency Response Act (AHERA). Unless asbestos fibres become airborne and can be inhaled, an intact asbestos sheet in a building poses little threat to the health of the inmates. However, building materials containing asbestos already in place may pose a risk to those carrying out alterations, maintenance and demolition. Such materials also have the potential to deteriorate over the years leading to exposure. Therefore, materials containing asbestos that have already been installed in a building should be protected from manipulation, periodically inspected for deterioration and left undisturbed as long as they are intact.

WHAT NEEDS TO BE EXPLORED FURTHER?
Clear guidelines are yet to be evolved for controlling asbestos
exposure in developing countries. Research is needed on the economic and operational feasibility of substituting chrysotile with non-asbestos materials. The combined effects of chrysotile fibres and other insoluble respirable particles also need to be further investigated.

To end the ongoing controversies about the basis of asbestos-induced carcinogenesis, further information on the molecular and cellular mechanisms is needed. Research is also needed to develop dose–response information from animal models for different types of asbestos fibre to demonstrate the differential risk of chrysotile and tremolite.

THE INDIAN SCENARIO
Asbestos figures among the top ten minerals imported in India. In spite of the fact that the value of imports of ores and minerals runs to thousands of crores of rupees and has shown a continuous rise during the 1980s and 1990s, asbestos remains in the company of prime import items such as petroleum and coal. We also produce our own asbestos. The annual indigenous production is about 30,000 tonnes and tops the table of non-metallic minerals in terms of quantity. However, the trend of consumption of asbestos products in India is such that in spite of indigenous production, it appears under the ‘deficit’ (in respect to demand) column in the status of mineral resources of India.

The most worrisome trend is the popular demand of asbestos in the building industry, though there are other areas of consumption such as industries dealing with friction materials, brake linings, seals and gaskets. Under the pressure of domestic demand, imports may continue. There is a recoverable deposit of 2.29 million tonnes of asbestos in our country, which may further be mined and released into our environment. All this will not be in agreement with our New Mineral Policy (1995), that has ‘minimizing adverse effects of mineral development on forest, environment and ecology’ and ‘ensuring the conduct of mining operations with due regard to safety and health of all concerned’ as two of its stated objectives. The problem is complex and unless we identify, promote and popularize safer substitutes for asbestos, it will not be suitably addressed.

SAFER SUBSTITUTES FOR ASBESTOS
There are several established alternatives to asbestos that do not depend on fibre technology. Materials such as corrugated polyvinyl chloride (PVC) and steel sheeting can replace asbestos in building material. Many non-asbestos fibres have also been developed and they can replace asbestos in a wide range of products. The commonest of these are polyvinyl alcohol (PVA), aramid and cellulose. They have been tested and found safer than asbestos by the Committee on Carcinogenicity, United Kingdom’s Department of Health and the European Commission Scientific Committee on Toxicity, Ecotoxicity and the Environment.

The process of substituting asbestos with safer materials may encounter difficulties which include the technical performance of the substitute and operational feasibility. Cost considerations will also come in but they should be seen in the perspective of the total cost of asbestos-related health hazards. New products may be costlier initially but the prices will come down rapidly with increasing demand and mass production. Looking at the issues at stake, these obstacles should not deter us from stopping further release of asbestos into our environment.

REFERENCES