Preventing the Burden of Occupational Cancer in Canada

Stakeholder Meeting Summary

NOVEMBER 5, 2015, TORONTO

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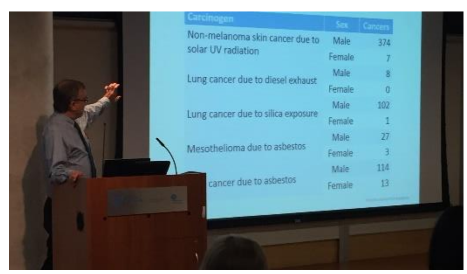

Acknowledgements

THANK YOU TO THE CANADIAN CANCER SOCIETY RESEARCH INSTITUTE

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WE ALSO WISH TO THANK:

The Occupational Cancer Research Centre's funders: the Ontario Ministry of Labour (MOL), Cancer Care Ontario (CCO), and the Canadian Cancer Society (CCS), Ontario Division. The OCRC was created in 2009 through the efforts of Ontario's Workplace Safety and Insurance Board (WSIB), CCS, CCO, and the United Steelworkers (USW).

Our opening and closing speakers: Mr. George Gritziotis (Chief Prevention Officer, MOL), Dr. Michael Sherar (President and CEO, CCO), Ms. Rowena Pinto (Vice President, Public Affairs & Strategic Initiatives, CCS, Ontario Division), and Dr. Linda Rabeneck (Vice President, Prevention and Cancer Control, CCO).

Our speakers:

- Dr. Paul Demers, OCRC, CCO (Overall Principal Investigator (PI) of the BOC Canada Study)
- Dr. Lesley Rushton, Imperial College London (Co-Leader of the UK Burden Project and Collaborator on the BOC Canada Study)
- Dr. Chris McLeod, Partnership for Work, Health and Safety, and School of Population and Public Health, University of British Columbia (Scientist on the BOC Canada Study)
- Dr. Emile Tompa, Institute for Work & Health (PI of the Economic Component of the BOC Canada Study)
- Ms. Donna Pasiechnik, CCS, Saskatchewan Division
- Mr. Alec Farquhar, Ontario Office of the Worker Adviser
- Ms. Joanne Kim, OCRC, CCO (Research Associate on the BOC Canada Study)
- Mr. Colin Murray, Risk Analysis Unit, WorkSafeBC
- Mr. Vic Pakalnis, MIRARCO Mining Innovation
- Mr. Jean-Paul Mrochek, USW Local 6500
- Dr. Cheryl Peters, Carleton University and CAREX Canada (Scientist on the Exposure Assessment Component of the BOC Canada Study)
- Ms. Natalia Mozayani, Radiation Safety Institute of Canada
- Dr. Anne-Marie Nicol, Simon Fraser University and CAREX Canada (Co-PI of the Knowledge Translation Component of the BOC Canada Study)
- Dr. Christine Williams, CCS National and CCSRI

Finally, thank you to Ms. Janet Brown for support with planning and meeting facilitation and to all attendees for their enthusiastic participation!

Photos on cover (clockwise): Audience; Dr. Paul Demers presenting an overview of the BOC Canada Study; Diesel engine exhaust panel, from left: Ms. Joanne Kim, Mr. Colin Murray, Mr. Vic Pakalnis, and Mr. Jean-Paul Mrochek

Overview of the Burden of Occupational Cancer in Canada Study

THE BURDEN OF OCCUPATIONAL CANCER IN CANADA STUDY AIMS TO ESTIMATE THE NUMBER OF CANCERS THAT ARE DUE TO CARCINOGENIC EXPOSURES IN THE WORKPLACE, AS WELL AS THE ECONOMIC COSTS ASSOCIATED WITH THESE CANCERS

The term ‘burden’ refers to the human impact (new cases, deaths, years of life lost) and the economic costs associated with a cause of disease. The study aims to assess the burden of 27 different cancers attributed to exposure to 44 workplace carcinogens, described by sex, province, age group, industry and occupation.

Cancer is the leading cause of death in Canada. Millions of Canadians are exposed to a range of known and suspected carcinogens in the workplace, but the full impact of these exposures is not clear. Findings from this study will help identify priority workplace carcinogens and provide policy makers and health advocates with quantitative information to inform cancer prevention initiatives. By quantifying cancer burden in terms of both lives and financial costs, the study’s results can be used to support more protective occupational exposure limits, foster toxics use reduction, and prioritize interventions for workers in the most high-risk jobs.

The human burden is calculated using data on exposure for each selected carcinogen; information about the numbers of people employed in exposed jobs; evaluations of cancer risk associated with each carcinogen; and the numbers of newly diagnosed cancers and cancer deaths each year in Canada. These data are combined to estimate the number of cancers and cancer deaths each year that could be prevented by reducing occupational carcinogen exposure (Appendix 1).

The economic burden includes all current and future costs incurred by afflicted workers, their families, communities, employers, and society at large. These costs include health care and administrative costs paid by society; informal caregiving and out-of-pocket costs; output and productivity losses, including lost wages and costs to the employer; and health-related quality of life losses incurred by workers and their families.

This four-year study is a national collaboration with input from internationally recognized cancer burden scientists. Funded by the CCSRI, this study involves researchers from OCRC, CAREX Canada, the Institute for Work & Health, University of British Columbia, Université de Montréal, Institut de recherche Robert-Sauvé en santé et en sécurité du travail, and Imperial College London. A unique aspect of this study is the close collaboration between the researchers and CCS.

In the first phase of the study, data about cancer risk and Canadian workplace exposure to cancer-causing agents were collected and analyzed to produce preliminary burden estimates. The second part of the study used these burden estimates to generate economic burden figures. Preliminary burden estimates are currently undergoing scientific review, while others are still in progress. The third stage of this project involves communicating the results to stakeholders so that the burden study findings can help advance cancer prevention initiatives across Canada.

Meeting Agenda and Participation

THIS MEETING BROUGHT TOGETHER INVITED SCIENTISTS AND STAKEHOLDERS TO SHARE INTERIM FINDINGS FROM THE BURDEN STUDY AND TO BEGIN DISCUSSION ABOUT USING THESE FINDINGS TO PROMOTE CANCER PREVENTION IN CANADA

Three carcinogens – diesel engine exhaust, asbestos, and radon – were discussed at the meeting. These agents were selected because of the large numbers of Canadian workers exposed to each of these well-established lung carcinogens, as well as interest in addressing these substances by stakeholders, including the Canadian Cancer Society. Additionally, these substances illustrated variations of the general burden methodology that was used for the study.

From left: Drs. Lesley Rushton, Paul Demers, and Christine Williams

Nearly 120 people attended and shared their diverse perspectives at this interactive meeting. There was representation from government (e.g. MOL, CCO, WSIB, Office of the Worker Adviser, and Public Health Ontario), organized labour (e.g. USW, Ontario Federation of Labour), health and safety system partners (e.g. Workplace Safety & Prevention Services, Infrastructure Health & Safety Association, Public Services Health & Safety Association, Occupational Health Clinics for Ontario Workers, and Workers Health & Safety Centre), non-governmental organizations (e.g. CCS, Radiation Safety Institute of Canada, Canadian Partnership Against Cancer, Canadian Environmental Law Association), the research community (e.g. Institute for Work & Health, Centre for Research Expertise in Occupational Disease), and others.

The meeting began with an overview of the burden study and a presentation about the experience of researchers from the United Kingdom who conducted a burden study upon which the Canadian approach is based. Each exposure (diesel engine exhaust, asbestos, and radon) was then addressed in detail with preliminary burden estimates and examples of relevant cancer prevention efforts in Canada. The meeting agenda and presenter biographies are on the OCRC website. Most presentations are also available on the OCRC website. Fact sheets summarizing the general Canadian BOC Study methodology and burden of cancer attributable to exposure to each of these three carcinogens are in Appendices 1-4.

Diesel Engine Exhaust

> **VOICES FROM THE WORKSHOP**
>
> *"Diesel is a leading issue in mining. Most mining people know we are going to eventually go electric, but diesel equipment is still the work horse of mining and will be around for the next 20 years."*
>
> *"We now need to implement the research we have as quickly as we can. But we need applied research to make sure we don't create new problems as we solve old ones."*

Diesel engine exhaust is a mixture of gases and particulates produced by the combustion of diesel fuel. It is a major component of air pollution. Diesel engine exhaust causes lung cancer, and there is limited evidence that it may cause bladder cancer. Occupations with the most workers exposed to diesel engine exhaust include truck drivers, heavy equipment operators, and transit operators (view the CAREX Canada diesel engine exhaust fact sheet for more information).

The standard burden methodology developed for the overall study was used to estimate the burden of cancer attributed to diesel engine exhaust exposure. This methodology is described in Appendix 1. Based on preliminary analyses, occupational exposure to diesel engine exhaust accounted for an estimated 553 lung cancers and 191 suspected bladder cancers annually in Canada, with an estimated cost of nearly $507.7 million for lung cancer alone (Appendix 2). Health-related quality of life losses accounted for approximately 82% of this total cost. Indirect costs, including replacement and training costs for new workers, and output and productivity costs, made up 11% of the total. Direct costs, including health care, out-of-pocket, family caregiving and administration costs, accounted for 7% of the total.

A major challenge in estimating the burden of cancers associated with occupational diesel engine exhaust is the lack of exposure data. This is partly due to the fact that diesel engine exhaust is a complex mixture that is challenging to measure, and also because it was classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC) as recently as 2012. Data from other jurisdictions and exposure-risk analyses were examined to fill in exposure data gaps.

There is currently no occupational exposure limit for diesel exhaust in Canada. Part of the challenge is that diesel engine exhaust is a mixture of different substances, and the composition of the mixture can change depending on the engine, fuel, type of operation, and emission control systems. At the meeting, WorkSafeBC's risk management approach for occupational exposure limits was discussed, which considers factors such as the number of workers exposed, occupational exposure limits in use in other jurisdictions, reported health effects, and ability to monitor and enforce the limit.

Diesel engine exhaust is a priority issue in underground mining. Though the industry will eventually transition to using electric motors, participants at the meeting indicated that diesel engines will likely be in use for at least another two decades. Developing ways to protect workers from exposure is important for miners' health in the interim. It is not feasible to achieve the targeted air quality levels by increasing ventilation rates in mines; diesel particulate matter needs to be controlled at the source. A multi-pronged approach is currently used, where diesel particulate filter systems are coupled with good ventilation practices, a well-planned maintenance program, low-emission engines, and high quality fuels and lubricants. New technologies show promising results for dramatically reducing diesel soot emissions, but feasibility in mining operations remains to be evaluated.

Asbestos

Asbestos is a well-established carcinogen that was used extensively in Canada for many decades. It can still be found in many older buildings and continues to be incorporated in certain products (e.g. brake pads, cement pipes). The largest numbers of exposed workers are in the specialty trade contracting and construction industries (view the CAREX Canada asbestos fact sheet).

> **VOICES FROM THE WORKSHOP**
>
> *"The burden [of mesothelioma] is significant yet all of these cancers are preventable; we have prevention strategies for asbestos."*
>
> *"This is a very important issue, because even if we ban asbestos now, it is still in so many locations."*

Preliminary study results were presented for the burden of lung cancer and mesothelioma due to occupational asbestos exposure, and how the approaches for mesothelioma and lung cancer differed from each other and from the standard burden methods. Based on a scientific review, nearly 85% of mesotheliomas in men and 40% in women are due to occupational asbestos exposure. Using these proportions, an estimated 391 mesotheliomas (77% of all cases) were found to be due to occupational asbestos exposure annually (Appendix 3).

Lung cancer was more complicated because it is also associated with a number of other occupational carcinogens. Based on a review of epidemiological studies, a ratio of 4.4 lung cancers to one mesothelioma was chosen to estimate the number of lung cancers based on the number of observed mesotheliomas. This number was the midpoint of a range taken from the North American studies, but there was a degree of uncertainty to the estimate. Approximately 1708 lung cancers were attributed to occupational asbestos exposure each year. This amounted to 7.4% of all lung cancers diagnosed annually in Canada (Appendix 3). Other ratio values may be used in further modeling of lung cancer burden, which will result in different estimates than these preliminary values. Preliminary economic results showed that for the target year of 2011, there would have been approximately $1.7 billion in savings if newly diagnosed cases of lung cancer and mesothelioma had been prevented. These economic estimates will be revisited in accordance with any changes to the human burden estimates.

There are several initiatives underway in Canada to prevent and control exposure to asbestos on the job. For example, Howard's Law mandates an asbestos registry for public buildings in Saskatchewan. This registry is now quite comprehensive for certain types of buildings, but other categories of buildings are not necessarily asbestos-free if they are not listed in the registry. There are concerns that only including public buildings could create a false sense of security. The next steps are to raise awareness about buildings containing asbestos, ensure that employers educate workers on how to recognize and safely deal with asbestos-containing materials, and to review asbestos abatement processes and responsibilities.

Implementation of asbestos restrictions and regulations has been slow. Historically, Canada was a major asbestos producer and exporter. Asbestos mining in Canada came to a halt in 2012, but asbestos-containing materials are still being used. There is now broad support for a complete asbestos ban and a national coalition is calling for a ban at the federal level. There are many complementary strategies that would, in conjunction with a ban, help mitigate the health and economic impacts of asbestos in the future. Some of these included a national asbestos remediation plan, a national building registry, a registry of Canadians exposed to asbestos (to support screening and early medical intervention), and advocating for a global ban.

Radon

> **VOICES FROM THE WORKSHOP**
>
> *"There is a question of where we set the threshold for risks. Most occupational exposures are much higher than exposures in homes, but with radon this is turned on its head."*
>
> *"Our board members still tear up when talking about Elliot Lake. We know 220 workers lost their lives to silica, radon, and uranium – and those are only the workers compensated. This passion transcends years."*

Radon is a naturally occurring radioactive gas that is emitted from uranium-containing rocks and soils. Levels vary geographically, and are generally highest in confined spaces or underground (view the [CAREX Canada radon fact sheet]).

Our standard burden methodology was not used for radon. Exposed workers were divided into two categories: those in high exposure jobs, such as mining, other underground work and some fisheries; and those who perform general indoor work. For general indoor workers, the challenge was to determine who works inside and close enough to the ground to be exposed above a threshold of 200 Bq/m^3 (the current Canadian residential guideline). Well-ventilated occupations, such as warehousing, were excluded. Urban centres were assumed to have more high rises, and therefore less exposure, than rural areas. As well, geographic variation in radon levels can be more important than occupation in determining exposure levels for radon.

Occupational radon exposure, using a threshold of 200 Bq/m^3, accounted for 26 lung cancers per year (Appendix 4). This preliminary estimate mainly reflected preventable lung cancers among highly exposed workers where radon levels are actionable based on current guidelines. Lung cancer burden will be reassessed for lower levels of occupational radon exposure.

Unlike many other exposures, residential radon levels tend to be higher than most occupational levels (with the exception of high-risk groups such as uranium miners). However, people often live close to where they work, so there may be a compounding of occupational and residential exposure if there are high radon levels in the geographical area. Because residential exposure can be a significant portion of total radon exposure, it is difficult to estimate the workplace contribution alone. More scientific input is needed before these estimates are finalized.

Health Canada estimates that 16% of lung cancers are attributable to radon exposure. However, there is no central agency responsible for radon in Canada and no nationally applicable regulation. The Canadian Guidelines for Management of Naturally Occurring Radioactive Material (NORM) have been developed by the Federal Provincial Territorial Radiation Protection Committee (FPTRPC) to harmonize standards throughout the country; however, there is considerable heterogeneity of occupational guidelines between provinces. Even within the same province there are differences in how legislation is applied. For instance, the Ontario Building Code only applies to three areas within Ontario with traditionally high levels of radon in soil. Additionally, the World Health Organization's exposure reference level for radon (100 Bq/m^3) is lower than the current Canadian guideline, highlighting the need for more protective standards in Canada overall.

Opportunities for preventing radon exposure in workplaces and homes include harmonizing reference levels for radon across jurisdictions, giving tax credits for radon remediation, strengthening enforcement, amending real estate regulations to include radon disclosures, and increasing data sharing between organizations. The ALARA (as low as reasonably attainable) principle could be applied for radon, as is done for other ionizing radiation, instead of requiring testing and remediation only if levels are above a certain threshold.

Meeting Themes

The meeting agenda was structured to allow for significant interaction and discussion. Notes were taken throughout, with special emphasis given to the questions and comments of the participants. A thematic summary was conducted of the dialogue that took place between the participants and the speakers. These are some of the major themes that emerged from this conversation.

1 – THE BURDEN RESULTS ARE A POWERFUL LEVER FOR CHANGE

The human and economic burden results of this study, once finalized, are expected to be a useful guide for policy-makers who often rely on quantitative data to make evidence-informed decisions. Existing or proposed prevention initiatives, such as the Ban Asbestos Canada coalition campaign and the Radon Awareness and Prevention Act 2014 ("Bill 11" in Ontario), can be supported by burden results to encourage greater action. The economic burden component was widely recognized as a unique aspect of this study. The potential to conduct cost-benefit analyses of interventions, as has been done in a follow-up to the UK burden study, was seen as an important research and policy need in Canada.

> *"If we don't do something now, we're going to have thousands of occupational cancers each year."*
>
> *– Workshop participant*

Legislative changes are sensitive to the overarching political climate, however. The results of the UK burden of occupational cancer study have been successful in raising awareness among stakeholders, but the country's political climate has not been conducive to recommended policy changes. Preventing occupational health risks can involve different branches of government; namely labour, health, and environment. In Ontario and in Canada, the political will and shifting priorities need to be considered when policy change is attempted.

The results from this study may also have implications for preventing exposure to environmental carcinogens. For instance, radon and asbestos could be present in both homes and work environments, and diesel engine exhaust contributes to ambient air pollution. When people are exposed to carcinogens as part of their jobs and during non-work time, their cumulative exposure is higher than from occupational exposure alone. However, the opportunities for intervention are greater in workplaces than in other settings. As Dr. Anne-Marie Nicol (CAREX Canada) stated, there are *"many more possibilities for change in occupational health. You can have regulations and compliance that do not happen in environmental settings. It is hard to make Canadians test their homes [for radon], but since we have a duty to make workplaces safer, it is easier to enforce radon policies in workplaces."*

> *"Cancer and chronic disease are steadily rising. The best thing we can do is to increase our prevention efforts."*
>
> *– Workshop participant*

2 – WHILE THE BURDEN STUDY METHODS ARE ROBUST, THERE ARE SOME ACKNOWLEDGED UNCERTAINTIES

Internationally, the Canadian burden study is an important advancement in burden methodology that may affect how burden studies are conducted elsewhere. This can improve global burden of disease estimates, providing much-needed information to help governments establish public health priorities and allocate resources to high-risk populations.

This study's preliminary burden estimates are based on models with varying degrees of uncertainty. Sources of uncertainty include exposure data sources, errors in the studies from which relative risks were drawn, and assumptions built into the models. It is therefore important that the methods are transparent and that the uncertainty is clearly communicated.

Some uncertainties were discussed in detail. For instance, radon levels and exposures vary geographically, which introduced an extra layer of modeling and assumptions. As well, a "threshold" approach was used for radon, where only workers who were deemed to be exposed over a certain level (200 Bq/m^3) were included in the burden estimate. The team is currently revisiting this approach, and plans on modeling burden using other threshold values for radon. In the case of asbestos, the number of lung cancers attributed to occupational asbestos exposure was calculated by using a ratio of 4.4 lung cancers for each mesothelioma. This ratio was determined from an extensive review of the literature, but represents the midpoint of a range of ratio values for North American studies. Other values based on different criteria are being evaluated to see if they are more appropriate for modeling lung cancer burden.

The burden study relied on IARC's evaluations of carcinogens. New information about occupational exposures and associated cancers will continue to emerge. Over the course of the UK burden study, IARC reclassified diesel engine exhaust as a Group 1 (known) human carcinogen, but its previous assessment of diesel as a Group 2A (probable) human carcinogen was used in the UK burden study since this was the latest evidence available at the time. Burden estimates may be revised in the future to reflect new research results. Furthermore, mechanisms of exposure-cancer associations are largely unclear, the synergistic effects of multiple exposures are not well understood, and many exposures need further investigation to determine if they are carcinogenic.

It is clear that a nuanced perspective needs to be taken and that the preliminary burden values produced from this study require cautious interpretation. They are estimates, and while the methods are transparent, reproducible, and robust, there are some uncertainties. The numbers presented at the meeting were preliminary estimates that will be further refined by the study's scientists and reviewed externally before being finalized.

3 THE BENEFITS, CHALLENGES AND RISKS OF INTERVENTIONS NEED TO BE CONSIDERED

Evidence-informed priority setting can help channel resources to where they will have the greatest impact. Even so, interventions are not without risk. For instance, asbestos abatement workers are known to be at high risk of exposure to asbestos. Abatement can reduce the number of people exposed to asbestos now and in the future, but it may expose abatement workers to high levels of asbestos, if not done properly. A careful consideration of benefits and harms to human health would need to be applied in this situation. Merely increasing awareness of risk may generate undue fear if not framed appropriately. Carefully framing and prioritizing interventions will contribute to their success.

4 WORKPLACE-BASED INTERVENTIONS NEED TO BE TAILORED TO BE EFFECTIVE

Preventing occupational cancer through workplace-based interventions can be impacted by factors such as industry or job, province, or type of workplace. Industries typically have unique challenges and different levels of knowledge and awareness of the risks associated with carcinogenic exposures. For instance, in the oil and gas industry in British Columbia, there has traditionally been a greater awareness of the risks of diesel engine exhaust exposure compared to levels of awareness of this hazard among other exposed groups, like truck drivers or ferry workers.

Major industries, exposures, and prevention opportunities can also differ between provinces and this may impact prevention strategies. For example, radon levels differ geographically; should different intervention strategies be used? Small workplaces often do not have access to the same protective measures as larger workplaces, and may not be held to the same occupational health and safety standards. These findings emphasized that workplace-based prevention initiatives need to be tailored in order to be effective.

In many cases, there are effective ways to control exposure but they are not happening consistently. Best practices for handling asbestos-containing materials, such as wet cutting, are not always strictly followed. Radon testing is not widespread in either workplaces or homes. Alternative energy sources, such as electric engines, could be used in place of diesel engines in the mining industry, or new filter technologies could significantly reduce diesel emissions, but these are generally not yet in place.

Participants agreed that it is challenging to ensure that prevention policies are followed but there is a joint responsibility to make workplaces safer and healthier. Industry leadership, even in the absence of regulation, can blaze the trail for lowering exposure to occupational carcinogens (e.g. for diesel engine exhaust, which currently lacks an occupational exposure limit). Increased awareness of the risks and the costs of occupational disease could help to promote prevention.

5 PARTNERSHIPS ARE NEEDED TO PREVENT OCCUPATIONAL CANCER

Working together is essential for preventing occupational cancer in Canada. Policy makers, advocacy groups, health and safety representatives, researchers, unions, and employers all have important roles to play in prevention. Breaking down silos between groups can lead to better data sharing and access in prevention campaigns. An important aspect of the burden study is the integrated partnership with the Canadian Cancer Society, who plan to use the study results to advocate for policy change at the government level. The Canadian Cancer Society described the power of stories in advocating for policy change in the absence of available research, and discussed how the burden estimates could be contextualized and integrated with other information to advocate for prevention. By sharing the findings with unions, employers, and health and safety system partners, we hope to promote prevention efforts at the workplace level.

Meeting participants from the Canadian Cancer Society

Next Steps for the Burden Study

THIS STUDY IS THE FIRST OF ITS KIND IN CANADA TO ESTIMATE THE NUMBER OF NEWLY DIAGNOSED AND FATAL CANCERS THAT CAN BE PREVENTED BY REDUCING EXPOSURE TO CARCINOGENS IN THE WORKPLACE

"This is a major undertaking. This project is estimating the impact. And what is important is how we go about prevention."

– Workshop participant

The following outlines our learning from the meeting and next steps.

- **Finalize burden estimates** with additional rounds of input from study scientists and international experts as needed.
- **Communicate and discuss the burden study**, including final results, at scientific and stakeholder meetings and through the publication of scientific and other documents (e.g. fact sheets on the OCRC, CCO, and research partners' websites).
- **Engage stakeholders** to discuss the potential implications of the study that are specific to their mandates, and to leverage their support in endorsing burden results in their sector (e.g. mining, construction).
- **Collaborate with the Canadian Cancer Society** across Canada to translate knowledge and integrate study findings in education, policy, and advocacy efforts.
- **Refine prevention messaging,** stating opportunities for primary prevention policies at the government and workplace levels (e.g. banning asbestos in Canada, developing a rigorous occupational exposure limit for diesel engine exhaust).
- **Inform existing prevention initiatives** with burden study results, highlighting economic burden estimates for potential policy changes (e.g. Bill 11 for radon).
- **Support the work of other scientific groups** evaluating the burden of occupational cancer in their jurisdictions (e.g. Latin America and the Caribbean) and contribute to global efforts in partnership with the UK burden study team and burden investigators from other countries.
- **Seek funding for additional research** to project the future burden of occupational cancer in Canada based on current exposures; investigate the human and economic costs and benefits of occupational cancer interventions (similar to the SHEcan project in the European Union); and evaluate joint effects of occupational and environmental carcinogen exposures on the burden of cancer in Canada (e.g. radon in workplaces and homes).

The Burden of Occupational Cancer in Canada Study is a collaborative study involving the following organizations:

Occupational Cancer Research Centre

Cancer Care Ontario

620 University Avenue

Toronto, Ontario, M5G 2L7

Canada

Web: http://www.occupationalcancer.ca

E-mail: ocrc@occupationalcancer.ca

Telephone: 416-217-1849

Fax: 416-971-6888

Appendices

1. Burden Study Overview and Methods

2. Diesel Engine Exhaust Fact Sheet

3. Asbestos Fact Sheet

4. Radon Fact Sheet

About Burden

Occupational Cancer Research Centre

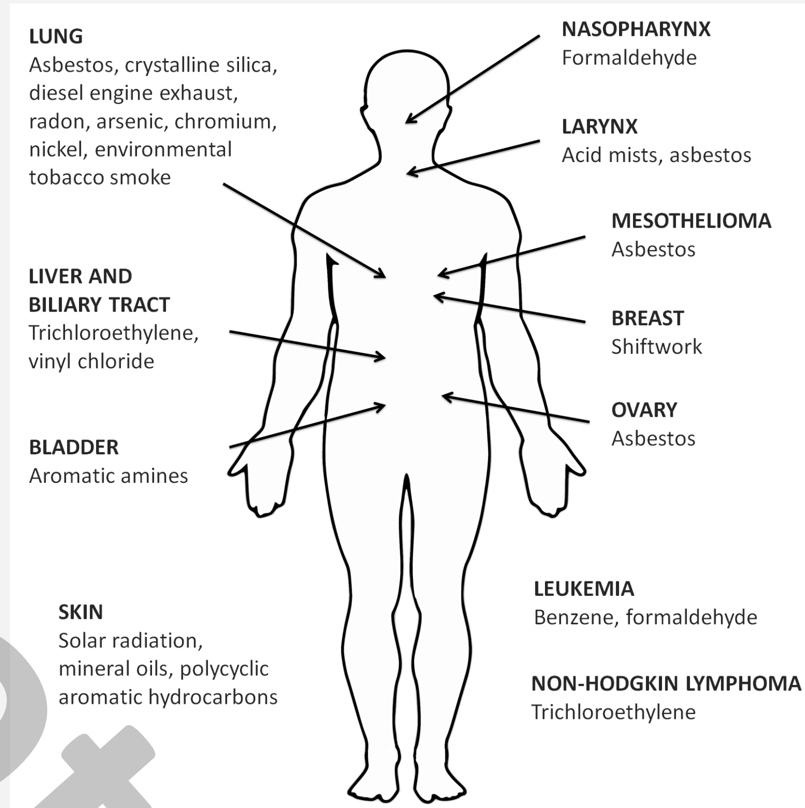
Estimating the burden of occupational cancer in Canada

What is burden?

The term ‘burden’ refers to the human impact (new cases, deaths, years of life lost) and the economic costs associated with a cause of disease.

The goal of the ***Burden of Occupational Cancer in Canada*** study is to estimate the **number of cancer cases** caused each year by exposure to workplace carcinogens, and the **economic impact** resulting from these cancers.

The study assesses the burden of 27 different cancers attributed to exposure to 44 workplace carcinogens. The burden will be described by sex, province, age group, industry and occupation. This enables identification of groups where the impact is highest, allowing for targeted prevention strategies.



The figure above shows some of the cancer sites and associated workplace exposures that are included in this study. These exposures were chosen from the International Agency for Research on Cancer’s evaluations of definite (Group 1) and probable (Group 2A) human carcinogens relevant to the Canadian context. They include industrial chemicals, dusts and fibres, radiation, metals, and exposure circumstances.

Why is this information important?

Cancer is the leading cause of death in Canada. Millions of Canadians are exposed to a wide range of known and suspected carcinogens in the workplace. However, the full impact of these occupational exposures is unclear, which is why burden studies are important.

Occupational cancer burden has not been previously calculated for Canada on a national scale. Cancers in the future can be prevented by reducing current occupational exposure to carcinogens. Findings from this study will help identify priority workplace carcinogens and will provide policy makers and health advocates with much-needed information to prevent occupational cancers.

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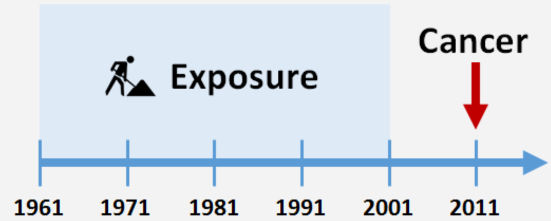
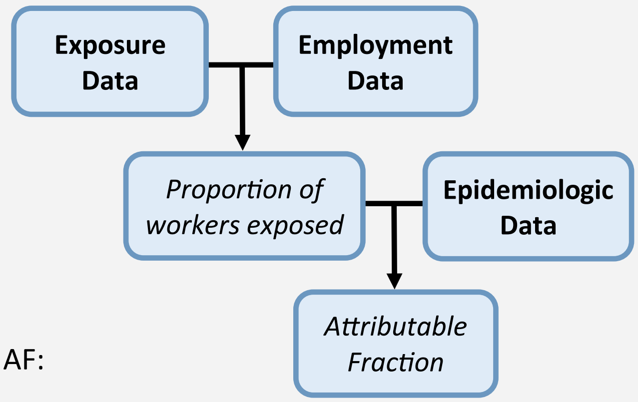
Estimating the human burden



Cancer has a long latency period, meaning that cancers can arise decades after exposure to a carcinogen. For this study, we assume exposures that occurred 10 to 50 years ago can contribute to current cancers. We estimated burden for the target year 2011 (the most recent census year).



Burden is estimated by first calculating the **attributable fraction (AF).** This is the proportion of cancers caused by a particular exposure, based upon how many people were exposed and the risk associated with their exposure. The AF is then applied to cancer statistics (e.g. the number of diagnosed cases in a given year) to estimate the number of cancers caused by the exposure.

There are three types of data that are used when calculating the AF:

- ***Exposure data*** tells us which jobs are exposed and the level at which they were exposed
- ***Employment data*** tells us how many people were employed in exposed jobs
- ***Epidemiologic data*** tells us the risk of cancer associated with each specific carcinogen (relative risk)

Estimating the economic burden

The economic burden of newly diagnosed occupational cancers in 2011 includes all current and future costs incurred by afflicted workers, their families, communities, employers and society at large:

- ***Health care and administrative costs:*** are incurred by employers if a workers' compensation claim is accepted, otherwise paid by society at large.
- ***Informal caregiving and out-of-pocket costs:*** include out-of-pocket healthcare and travel costs associated with medical treatments incurred by the worker and their family, and informal caregiving time from family or community members.
- ***Output and productivity losses:*** include lost wages for the worker due to time loss associated with illness or death, if not covered by workers' compensation and/or disability insurance. Employers also incur costs from the lost output and productivity associated with lost time and worker replacement.
- ***Health-related quality of life losses:*** intangible costs incurred by the worker and their family.

About the research team

The Burden of Occupational Cancer Project is a collaboration between researchers at OCRC, CAREX Canada, the Institute for Work & Health, University of British Columbia, Université de Montréal, Institut de recherche Robert-Sauvé en santé et en sécurité du travail, and Imperial College London. The project is funded by the Canadian Cancer Society. For more information, visit www.occupationalcancer.ca/2011/burden-of-occupational-cancer/.

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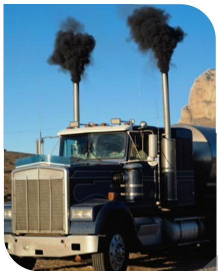
Diesel Engine Exhaust—Preliminary Results

Occupational Cancer Research Centre

The burden of lung cancer from workplace exposure to diesel exhaust in Canada

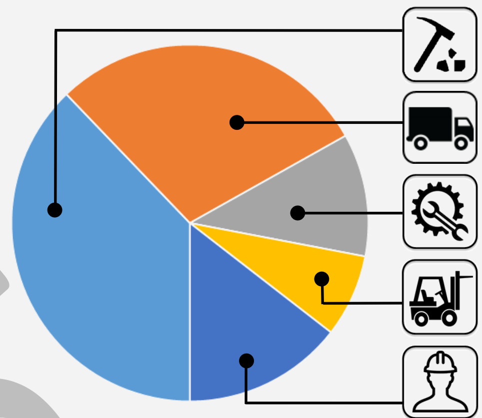


How many cancers are caused by diesel exhaust exposure at work?

Based on preliminary results, each year occupational exposure to diesel engine exhaust causes an estimated **553 lung cancers** in Canada. This amounts to **2.4% of lung cancer cases** diagnosed annually. Diesel engine exhaust is also a probable cause of bladder cancer, and causes an estimated 191 suspected cases of bladder cancer each year. This fact sheet focuses on lung cancer.

Who is most affected?

Most of the lung cancer burden occurs among **miners** and **truck drivers** (209 and 126 lung cancers, respectively). Other affected workers are **mechanics & repairers** of diesel engines (62 cancers), and **material handlers** (41 cancers). More than 10 cancers each year occur among forestry and logging workers, bus drivers, protective service occupations (e.g. firefighters), railway transport occupations, and taxi drivers.



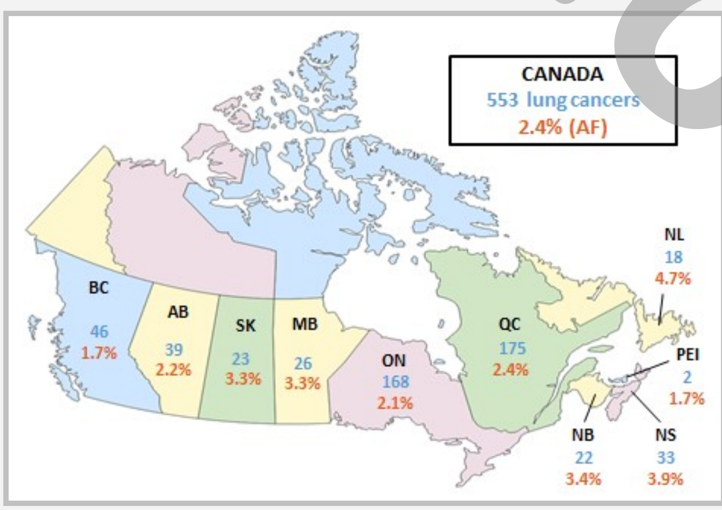
MINERS (38%)
209 lung cancers

TRUCK DRIVERS (23%)
126 lung cancers

MECHANICS (11%)
62 lung cancers

MATERIAL HANDLERS (8%)
41 lung cancers

OTHER (21%)
114 lung cancers



The burden of lung cancer can be shown by both the **number of cases** and the **attributable fraction** (AF). The AF is the proportion of cancers caused by diesel exhaust exposure, versus other causes. The **number of cases** is somewhat proportionate to the population in each province. The **attributable fraction** is higher in provinces that have disproportionately more exposed workers, especially when these workers are in more highly exposed industries.

What is the economic impact of occupational lung cancer caused by diesel exhaust exposure?

Work-related diesel exhaust exposure resulted in approximately **$507.7 million** in costs for newly diagnosed lung cancer cases in 2011. These costs are based on preliminary estimates of the number of attributable cancer cases, and will be updated when the estimates are finalized.

This value includes health care expenses and administrative costs of $15.5 million, informal caregiver and out-of-pocket costs of $18.7 million, output and productivity losses of $54.3 million, and health-related quality of life losses valued at $419.2 million.

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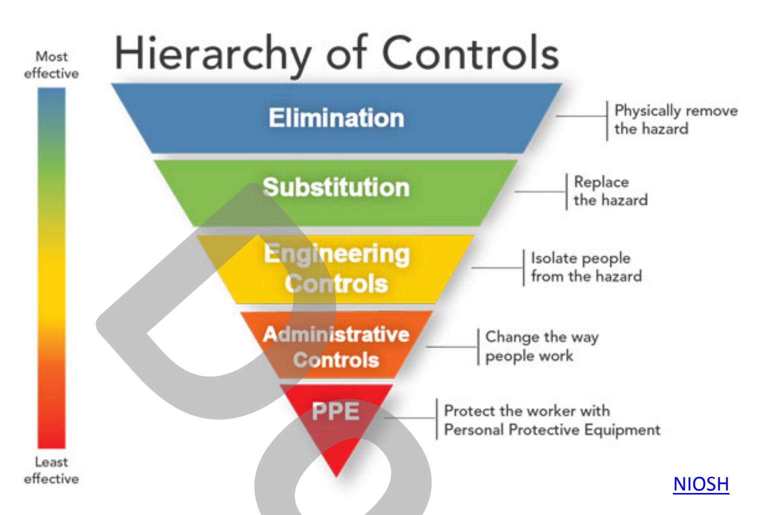
What can we do to reduce the burden of cancer caused by workplace exposure to diesel exhaust?



Work-related cancers can be prevented by reducing the number of workers exposed and the levels to which they are exposed.

In occupational hygiene, there is a hierarchy of hazard control strategies that ranges from most effective (elimination of the exposure) to least effective (use of personal protective equipment).

Another effective strategy for prevention is policy change.

Elimination or substitution

- Choose fuel alternatives such as electricity or natural gas
- Switch to low-emission diesel engines
- Use low-sulfur diesel fuel

Administrative controls

- Perform regular engine maintenance
- Avoid idling engines
- Restrict the number of diesel-powered devices operating in a given area
- Run engines outdoors if possible

Personal protective equipment

- Wear respirators and eye protection when working near diesel engines

Engineering controls

- Use catalytic converters, tailpipe exhaust extraction systems, and filters attached to tailpipes to reduce emissions
- Use adequate ventilation when operating indoors
- Prevent exhaust from entering vehicles' cabs by filtering the air supply to cabs and sealing cracks or holes in the bodies of cars and trucks with weather stripping

Policy change

- Introduce an Occupational Exposure Limit for diesel exhaust in Reg. 833. The OCRC recommends a limit of 20 $\mu g/m^3$ for the mining industry, and 5 $\mu g/m^3$ for other workplaces, both measured as elemental carbon.

About the Burden of Occupational Cancer in Canada Study

The Burden of Occupational Cancer in Canada study aims to quantify the number of cancers that are caused by exposure to carcinogens in the workplace and the economic costs associated with these cancers in order to promote prevention. The study is funded by the Canadian Cancer Society. For more information visit www.occupationalcancer.ca/2011/burden-of-occupational-cancer/.

The Burden of Occupational Cancer in Canada study is a collaboration between researchers at OCRC, CAREX Canada, the Institute for Work & Health, University of British Columbia, Université de Montréal, Institut de recherche Robert-Sauvé en santé et en sécurité du travail, and Imperial College London. This fact sheet was produced by OCRC (www.occupationalcancer.ca) and CAREX Canada (www.carexcanada.ca).

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Asbestos—Preliminary Results

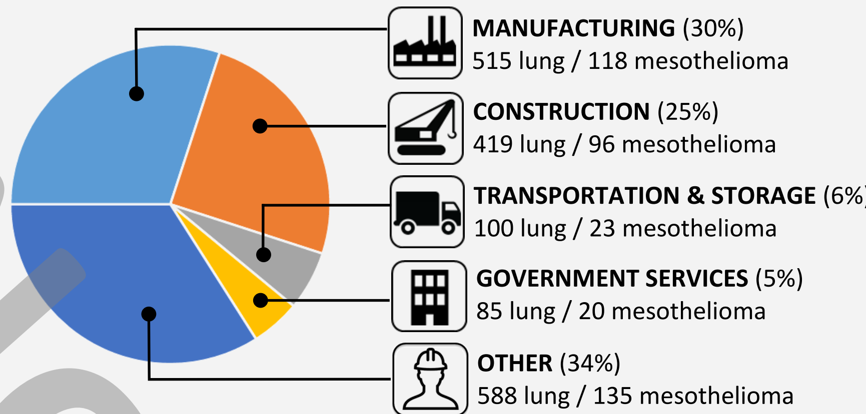
The burden of cancer from workplace exposure to asbestos in Canada

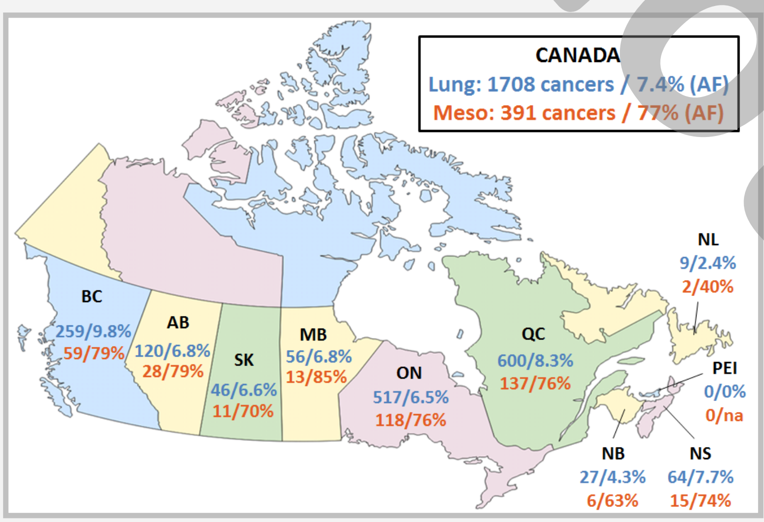
How many lung cancers & mesotheliomas are caused by asbestos exposure at work?

Based on preliminary estimates, each year occupational exposure to asbestos causes an estimated **1708 lung cancers** and **391 mesotheliomas** in Canada. This amounts to **7.4% of lung cancers** and **77% of mesotheliomas** diagnosed annually. Asbestos exposure is responsible for almost all mesotheliomas, with most of the remaining 23% caused by non-occupational asbestos exposure. Asbestos also causes laryngeal and ovarian cancers.

Who is most affected?

Most asbestos-related cancers are diagnosed among workers in **manufacturing** and **construction** (30% and 25% respectively). To a lesser extent, these cancers also occur among workers in **transportation and storage** (6%) and **government services** (5%). The industry distribution of these cancers reflects accepted Canadian workplace compensation claims.





Based on an analysis of scientific studies, we assumed that an estimated 85% of male and 40% of female mesotheliomas are related to occupational asbestos exposure. Thus, there is little variability between the provinces in the attributable fraction (AF) for mesothelioma. The AF is the proportion of cancers that can be attributed to occupational asbestos exposure.

Based on a further analysis of scientific studies, we estimated that there are 4.4 asbestos-related lung cancers for every mesothelioma.

What is the economic impact of occupational lung cancer and mesothelioma caused by asbestos?

Work-related asbestos exposure resulted in approximately **$1.36 billion** and **$359.3 million** in costs for newly diagnosed cases of lung cancer and mesothelioma, respectively, in 2011. These costs are based on preliminary estimates of the number of attributable cancer cases, and will be updated when the estimates are finalized.

This value includes health care expenses and administrative costs ($72.2 million for lung cancer, $50.9 million for mesothelioma), informal caregiver and out-of-pocket costs ($57.7 million, $10.1 million), output and productivity losses ($119.1 million, $28.6 million), and health-related quality of life losses ($1.11 billion, $269.7 million).

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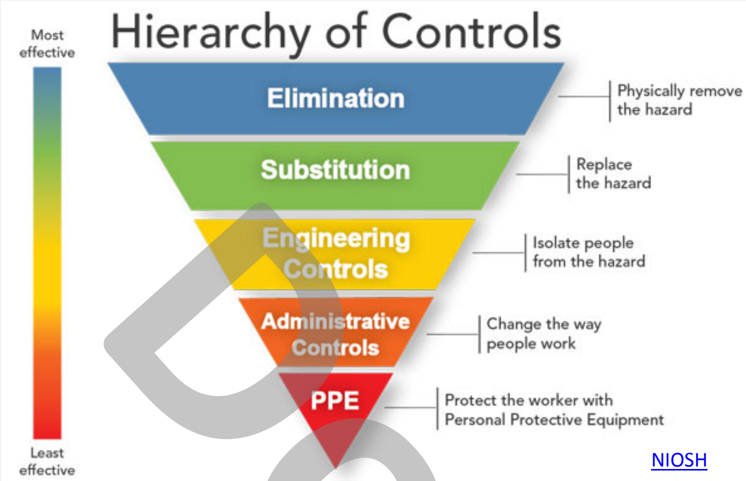
What can we do to reduce the burden of cancer caused by workplace exposure to asbestos?



NIOSH

Work-related cancers can be prevented by reducing the number of workers exposed and the levels to which they are exposed.

In occupational hygiene, there is a hierarchy of hazard control strategies that ranges from most effective (elimination of the exposure) to least effective (use of personal protective equipment).

Another effective strategy for prevention is policy change, and in some cases, modifying other risk factors for cancer.

Elimination or substitution

- Use products or materials that do not contain asbestos
- Safely remove and dispose of asbestos-containing materials found in the workplace

Engineering controls

- Seal off work areas where asbestos is present
- Make sure there is adequate ventilation at jobs where there is asbestos present
- Provide change rooms with showers and lockers so that street and work clothes remain separate

Administrative controls

- Clearly mark areas where asbestos is present
- Use wet clean up methods or high-efficiency particulate air (HEPA) vacuums to clean equipment, work surfaces and the floor—avoid dry sweeping or compressed air
- Seal up asbestos-containing waste and have it removed from the workplace
- At the end of the shift, put work clothes in asbestos-containing storage and shower before putting on street clothes
- Don't eat, drink, chew, or smoke within any work areas containing asbestos

Personal protective equipment

- Wear fit-tested respirators, protective suits, eye protection, gloves and boots to reduce exposure to asbestos

Modifiable risk factors

- Quit smoking: smokers who are exposed to asbestos are at a much higher risk of lung cancer

Policy change

- Ban all uses of asbestos in Canada
- Develop a national program for the elimination of asbestos-related diseases

About the Burden of Occupational Cancer in Canada Study

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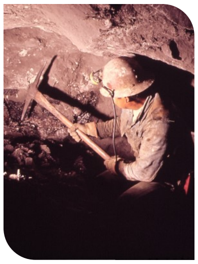
Radon—Preliminary Results

Occupational Cancer Research Centre

The burden of lung cancer from workplace exposure to radon in Canada



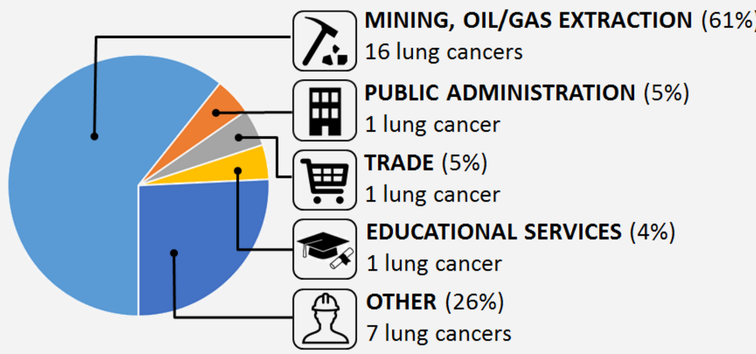
How many lung cancers are caused by radon exposure at work?

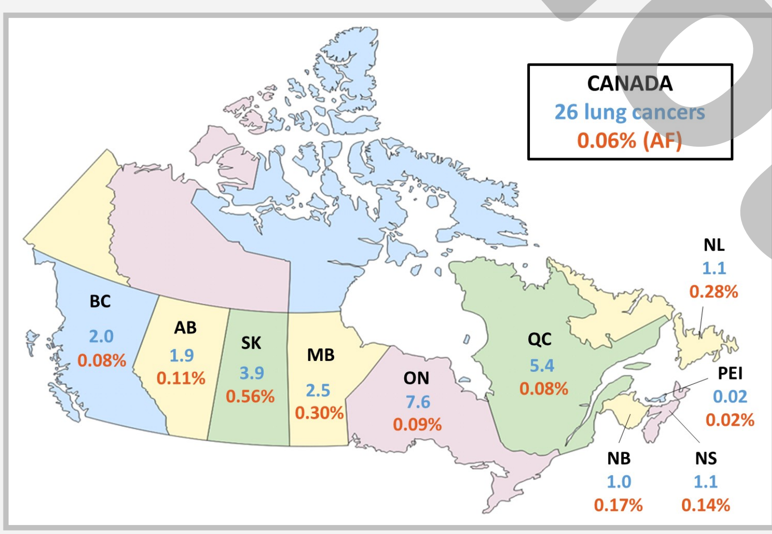
Based on preliminary results, each year occupational exposure to radon causes an estimated **26 lung cancers** in Canada. This amounts to **0.06% of lung cancers** diagnosed annually. The combined impact of occupational and residential radon exposure on lung cancer in Canadians has not been quantified.

Who is most affected?

Indoor occupational radon exposure accounts for an estimated 10 lung cancers each year. Workers who are exposed to radon indoors are mostly office workers in a variety of administrative, managerial, professional, and technical occupations.

Workers in the mining, oil, and natural gas extraction industry are exposed to high levels of radon at work. Approximately 16 lung cancers each year in these workers are caused by occupational radon exposure.





The attributable fraction (AF) represents the proportion of lung cancers that are caused by occupational radon exposure. The AF for highly exposed and indoor-exposed workers combined is 0.06% for Canada; of this fraction, nearly two-thirds is accounted for by highly exposed workers (in the mining, oil, and natural gas extraction industry).

Geographic variation in radon levels and in the natural resource extraction industry account for some of the differences in AF across provinces.

What is the economic impact of occupational lung cancer caused by radon?

The economic burden of lung cancer cases newly diagnosed in 2011 that were associated with work-related radon exposures amounts to **$30.6 million**. These costs are based on preliminary estimates of the number of attributable cancer cases, and will be updated when the estimates are finalized.

This value includes health care expenses and administrative costs of $740 thousand, informal caregiver and out-of-pocket costs of $893 thousand, output and productivity losses of $4.1 million, and health-related quality of life losses valued at $24.9 million.

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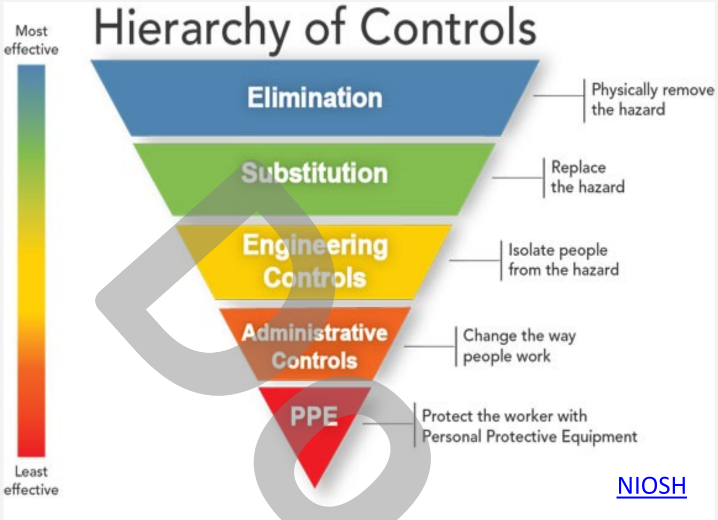
What can we do to reduce the burden of occupational lung cancer caused by radon?



NIOSH

Occupational lung cancer can be prevented by reducing the number of workers exposed to radon and the levels to which they are exposed.

In occupational hygiene, there is a hierarchy of hazard control strategies that range from most effective (elimination of the exposure) to least effective (use of personal protective equipment).

Policy change is another effective strategy for prevention. In some instances, modifying other lung cancer risk factors can be useful.

Elimination or substitution

- Use raw materials that are low in naturally occurring radioactive material

Administrative controls

- Test radon levels at worksites
- Compare radon levels on job sites to appropriate regulations for radon exposure

Modifiable risk factors

- Quit smoking: smokers who are exposed to radon are at a much higher risk of lung cancer
- Test for and reduce radon exposure at home: being exposed at home as well as at work increases the risk of lung cancer

Engineering controls

- Ensure that new buildings have appropriate measures built in to prevent radon exposure
- Make changes to existing buildings so that radon cannot enter or is actively removed from indoor areas. Strategies for remediating radon concentration in buildings include, from most to least effective: depressurization, active ventilation, passive ventilation, and sealing.

Personal protective equipment

- As a last resort, wear respirators to reduce exposure to radon

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