Brief Update On Diesel Health Effects

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The findings and conclusions in this report are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Outline of Presentation

- Overview of Diesel Health Effects
- IARC 2012 Evaluation of Carcinogenicity of Diesel Exhaust
- Follow-up to Diesel Exhaust in Miners Study (DEMS)

Health Canada's Summary of Health Effects of Exposure to Diesel Exhaust

Outcome	Acute/chronic DE exposure	Causality determination
Carcinogenicity	Chronic	Causal (lung cancer) Suggestive (bladder cancer) Inadequate (other cancers)
Respiratory effects	Acute	Causal
	Chronic	Likely
Cardiovascular effects	Acute	Likely
	Chronic	Suggestive
Immunological effects	–	Likely
Reproductive and developmental effects	–	Suggestive
Central nervous system effects	Acute	Suggestive
	Chronic	Inadequate

Human Health Risk Assessment for Diesel Exhaust. 2016. Available at: http://publications.gc.ca/site/eng/9.810907/publication.html

International Agency for Research On Cancer (IARC), 2012

6.1 Cancer in humans

There is *sufficient evidence* in humans for the carcinogenicity of diesel engine exhaust. Diesel engine exhaust causes cancer of the lung. A positive association has been observed between exposure to diesel engine exhaust and cancer of the urinary bladder.

There is *inadequate evidence* in humans for the carcinogenicity of gasoline engine exhaust.

6.3 Overall evaluation

Diesel engine exhaust is *carcinogenic to humans* (Group 1).

Gasoline engine exhaust is *possibly carcinogenic to humans (Group 2B).*

IARC Monographs on the evaluation of carcinogenic risks to humans; v. 105

Basis for IARC Determination

- "The most influential epidemiological studies assessing cancer risks associated with diesel-engine exhausts investigated occupational exposure among non-metal miners, railroad workers, and workers in the trucking industry." Lancet Oncol. 2012; 13(7):663-664

- Studies cited as most influential:

Attfield MD, Schleiff PL, Lubin JH, et al. The Diesel Exhaust in Miners study: a cohort mortality study with emphasis on lung cancer. J Natl Cancer Inst. 2012 Jun 6;104(11):869-83.

Silverman DT, Samanic CM, Lubin JH, et al. The Diesel Exhaust in Miners study: a nested case-control study of lung cancer and diesel exhaust. J Natl Cancer Inst. 2012 Jun 6;104(11):855-68.

Garshick E, Laden F, Hart JE, et al. Lung cancer in railroad workers exposed to diesel exhaust. Environ Health Perspect. 2004 Nov;112(15):1539-43.

Laden F, Hart JE, Eschenroeder A, et al. Historical estimation of diesel exhaust exposure in a cohort study of U.S. railroad workers and lung cancer. Cancer Causes Control. 2006 Sep;17(7):911-9.

Garshick E, Laden F, Hart JE, et al. Lung cancer and vehicle exhaust in trucking industry workers. Environ Health Perspect. 2008 Oct;116(10):1327-32.

Garshick E, Laden F, Hart JE, et al. Lung cancer and elemental carbon exposure in trucking industry workers. Environ Health Perspect. 2012 Sep;120(9):1301-6.

Health Effects Institute (HEI), 2015

- Published *Diesel Emissions and Lung Cancer: An Evaluation of Recent Epidemiological Evidence for Quantitative Risk Assessment*

  - This report is a careful review by an independent scientific panel of two major epidemiological studies of historical exposures to diesel exhaust, the Diesel Exhaust in Miners Study (DEMS) and the Trucking Industry Particle Study (Truckers) to assess whether these studies could provide the basis for quantitative risk assessment.

  - In the Panel's view, both the Truckers study and the DEMS were well-designed and well-conducted studies that each made considerable progress toward addressing a number of the major limitations that had been identified in previous epidemiological studies of diesel exhaust and lung cancer.

  - The Panel found that the studies have many strengths, but any effort at quantitative risk assessment will need to acknowledge some key uncertainties and limitations.

  - The Panel concluded that both the DEMS and the Truckers study provided results and data that provide a useful basis for quantitative risk assessments of exposures in particular to older diesel engine exhaust.

Follow-Up to the Diesel Exhaust in Miners Study

- Access to data underlying DEMS were made available to interested investigators, including a team funded by the Truck & Engine Manufacturers Association (EMA)

- EMA-supported publications raising criticisms of DEMS and presenting alternative data analyses:

Chang ET, Lau EC, Van Landingham C, et al. Reanalysis of Diesel Engine Exhaust and Lung Cancer Mortality in the Diesel Exhaust in Miners Study Cohort Using Alternative Exposure Estimates and Radon Adjustment. Am J Epidemiol. 2018 Jun 1;187(6):1210-1219.

Crump KS, Van Landingham C, McClellan RO. Influence of Alternative Exposure Estimates in the Diesel Exhaust Miners Study: Diesel Exhaust and Lung Cancer. Risk Anal. 2016 Sep;36(9):1803-12.

Crump KS, Van Landingham C, Moolgavkar SH, et al. Reanalysis of the DEMS nested case-control study of lung cancer and diesel exhaust: suitability for quantitative risk assessment. Risk Anal. 2015 Apr;35(4):676-700.

Moolgavkar SH, Chang ET, Luebeck G, et al. Diesel engine exhaust and lung cancer mortality: time-related factors in exposure and risk. Risk Anal. 2015 Apr;35(4):663-75.

- DEMS investigator responses:

Silverman DT. Am J Epidemiol. 2018 Sep 6. PubMed PMID: 30192912.

Silverman DT. Diesel Exhaust and Lung Cancer-Aftermath of Becoming an IARC Group 1 Carcinogen. Am J Epidemiol. 2018 Jun 1;187(6):1149-1152.

Follow-Up to the Diesel Exhaust in Miners Study

- Ongoing studies based at NCI
- Suggested associations between ischemic heart disease and exposure to respirable elemental carbon and/or respirable dust

Costello S, Attfield MD, Lubin JH, et al. Ischemic Heart Disease Mortality and Diesel Exhaust and Respirable Dust Exposure in the Diesel Exhaust in Miners Study. Am J Epidemiol. 2018 Dec 1;187(12):2623-2632.

Neophytou AM, Costello S, Picciotto S, et al. Diesel exhaust, respirable dust, and ischemic heart disease: an application of the parametric g-formula. Epidemiology. 2018 Nov 27. PubMed PMID: 30489348.

- Efforts underway to extend mortality follow-up of DEMS cohort and case-control studies from 1997 (original studies) to 2015

Health Effects Institute (HEI), 2015

- Published *The Advanced Collaborative Emissions Study (ACES)*

- ACES set out to evaluate emissions and health effects from new-technology (MY 2007 and 2010) heavy-duty, on-road diesel engines.

- The results show that the aftertreatment technologies used in such modern diesel engines are highly effective and that they meet — and exceed — the reductions mandated by U.S. regulations. The study reports the effectiveness of diesel particulate filters in greatly reducing PM emissions and of selective catalytic reduction systems in reducing NO_x emissions; similarly, emissions of more than 300 other compounds — some with known carcinogenic and toxic properties — measured in the exhaust were also reduced relative to exhaust from traditional-technology diesel engines.

- ACES results demonstrate, even after considering some inherent limitations in any such study, that diesel particulate filters greatly reduce the amount of PM from modern diesel engines and that the overall toxicity of exhaust from modern diesel engines is significantly decreased compared with the toxicity of emissions from traditional-technology diesel engines.

- Exposure to new-technology diesel exhaust (NTDE) from a 2007 engine tested in Phase 3 of ACES was not carcinogenic in the rat, unlike traditional-technology diesel exhaust (TDE) from older engines, which is known to cause lung tumors under similar conditions. A few NTDE-associated effects in rat lungs in ACES were observed; however, these effects were consistent with exposure to NO_2, a pollutant present in 2007 engine emissions that was further reduced in exhaust from MY 2010 engines, which deployed a selective catalytic reduction system.

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Thank you!