

Occupational toxic inhalation of carbon monoxide among Washington workers, 2017 – 2022

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INTRODUCTION

Carbon monoxide (CO) is a well-known and common workplace hazard, particularly in the agriculture and construction industries ^[1,2]. Two previous analyses of occupational CO exposure in Washington showed that propane-powered forklifts in agricultural cold storage warehouses were a predominant source of CO poisoning for the period 1994-2005 ^[1,2]. The adoption of electric-powered lifts and the manufacture of cleaner burning propane forklift engines in accordance with EPA regulations (EPA 40 CFR part 1048) may have contributed to a reduction in CO cases caused by propane forklifts noted for the period 2017-2020 ^[3].

Washington's toxic inhalation surveillance system characterizes inhalation exposures from vapor, gas, dust or fume that may result in either acute injury or chronic disease. Using workers' compensation data, the surveillance system captures eight priority exposures (carbon monoxide, ammonia, beryllium, chlorine, chromium, metal fume, methylene chloride, and wildland smoke) as well as an open-ended case capture for other chemical, metal, organic, or inorganic substances. The goal of the surveillance system is to identify emerging patterns in hazardous workplace exposures and guide prevention activities. We have previously published a complete description of the surveillance methods and analysis of toxic inhalation claims from 2017-2020 ^[3,4].

In this report, we will summarize the carbon monoxide surveillance methods and describe trends in exposures for 2017-2022 by industry, occupation, and source. This report includes data from 2021-2022 not previously published. The impetus for this report was a data request from the WA State Interagency Carbon Monoxide Workgroup (HB 1779 2023-24), which aims to document incidents and causes to carbon monoxide exposure across the state.

¹ Lofgren, D. Occupational carbon monoxide poisoning in the State of Washington, 1994-1999. 2002. *App Occup Env Hyg* (4):286-95. [doi: 10.1080/10473220252826592](https://doi.org/10.1080/10473220252826592).

² Reeb-Whitaker, C, D Bonauto, S Whittaker, and D Adams. Occupational carbon monoxide poisoning in Washington State, 2000-2005. 2010. *J Occup Environ Hyg* (10):547-56. [doi: 10.1080/15459624.2010.488210](https://doi.org/10.1080/15459624.2010.488210).

³ Washington State Department of Labor and Industries. Surveillance of toxic inhalation for Washington workers, 2017-2020. August 2021. SHARP Publication # 64-30-2021. Safety and Health Assessment and Research for Prevention Program, Olympia WA. https://lni.wa.gov/safety-health/safety-research/files/2021/64_30_2021_SurveillanceToxicInhal_2017-2020.pdf.

⁴ Washington State Dept of Labor and Industries. Supplementary Report: Methods and evaluation for Washington State's toxic inhalation surveillance system, 2017 – 2020. August 2021. Safety and Health Assessment and Research for Prevention (SHARP) . https://lni.wa.gov/safety-health/safety-research/files/2021/64_30_2021_SurveillanceToxicInhal_2017-2020.pdf.

METHODS

The data source for the surveillance system is the Washington State Department of Labor and Industries (L&I) workers' compensation system. In Washington State, nonfederal employers are required to obtain workers' compensation insurance through L&I unless they meet specific requirements to self-insure or are covered under an alternative workers' compensation program. L&I's State Fund insurance program provides coverage for approximately 1.9 million (about two-thirds) of the workers in the state and 99.7% of all employers.

Potential cases are captured using injury narrative keywords, International Classification of Disease (ICD-10-CM) codes, and Occupational Injury and Illness Classification System (OIICS) codes. We review the claim initiation form, the medical records, and correspondence with L&I to identify the substance(s) to which the worker was exposed. Our case validation process is independent of L&I's decision to accept or deny the claim. Rejected claims are included all analyses within this report. Our case definition for CO exposure is a known or suspected inhalation exposure to carbon monoxide, as stated by the worker, their employer, or physician. An abnormal result on a carboxyhemoglobin blood test can be supporting evidence for a workplace exposure but is not a required part of our case definition.

Furthermore, our case definition does not include any specific symptoms of CO exposure or medical outcomes. As our prevention activities aim to reduce exposures, the focus of our surveillance system and reporting are exposures rather than medical outcomes. L&I covers a worker's initial medical encounter regardless of whether an injury or disease subsequently manifests. Workers exposed to carbon monoxide may present to the emergency room with symptoms such as shortness of breath, dizziness, nausea or vomiting. These symptoms may resolve with oxygen, or have had already resolved by the time the worker was seen by the provider.

Workers may report a CO exposure from natural gas leaks, which often result in facility evacuations and the involvement of the fire department. While natural gas can give rise to similar symptoms as CO exposure through oxygen displacement, combustion is required to produce CO. The claim documentation must contain some description of combustion for the case to be valid.

While workers' compensation is a rich source of information on emerging hazards, it likely undercounts the true number of exposures. If the CO exposure did not require medical care or time off work, it is less likely that the exposed worker would file a claim. Larger systemic factors such as language and administrative barriers reduce overall claim filing.

The industry and occupation of the case is coded by L&I using the North American Industry Classification System 2007 (NAICS, version 2007) and the Standard Occupation Codes 2002 (SOC).

RESULTS

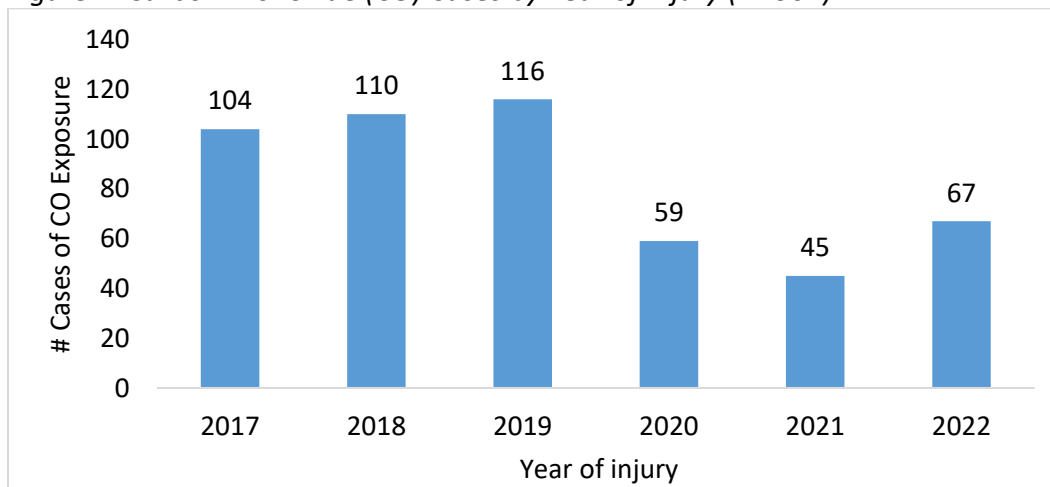
Among all workers compensation claims established between 2017 and 2022, our toxic inhalation surveillance system captured 1,186 potential cases of CO exposure. The medical record for each potential case was manually reviewed and we determined that 507 cases met our case definition and were valid for CO exposure.

Valid cases were filed by predominantly male workers (68%), with a median age of 38 years at the time of injury. By vulnerable age group, 12 cases were filed by workers aged nineteen or younger and 13 cases were filed by workers aged 65 or older. The preferred language for the claim process was English in 93% of cases, Spanish in 6% of cases, and all other languages in 1% of cases. Claims were accepted by L&I 61% of the time. The median claim cost was \$543 and the median medical claim cost was \$402 (N=507). Fifteen claims had one or more days of paid time loss, with a median of 27 days among claims with time loss. CO exposures peaked in 2019, with 116 exposures occurring that year (Figure 1).

The industry sector with the greatest number of CO cases was Public Administration, which includes police officers, firefighters, and other government employees (Table 1). The occupational group with the greatest number of CO cases was Transportation and Material Moving (Table 2). Vehicles such as cars and trucks were the most common source of carbon monoxide exposure (43% of cases, Table 3). The occupation most frequently exposed to CO from vehicles are “Transportation and Material Moving Occupations” (84 cases) and “Protective Service Occupations” (71 cases), which includes police officers and security guards (Table 4).

CO exposures among “Protective Service Occupations” peaked in 2019, with 31 cases that year (Figure 2). Vehicles were the source of CO exposure for 60 cases with injury years in the period 2017-2019 and 11 cases with injury years in the period 2020-2022.

Figure 1. Carbon Monoxide (CO) Cases by Year of Injury (N=501)¹



¹ Seven additional cases were filed (established) in the period 2017-2022 and had a year of injury prior to 2017; this data is not included in the graph.

Table 1. Carbon Monoxide Exposure Cases by NAICS Industry Sector

NAICS Industry Sector	# Cases
Public Administration	98
Transportation and Warehousing	71
Construction	63
Accommodation and Food Services	37
Health Care and Social Assistance	36
Administration, Support, Waste Management, and Remediation Services	30
Agriculture, Forestry, Fishing and Hunting	26
Retail Trade	26
Manufacturing	24
Wholesale Trade	20
All other industry sectors	67
Unknown or Non-classifiable	10
Total	507

Table 2. Carbon Monoxide Exposure Cases by SOC Occupation Group

SOC Occupation Group	# Cases
Transportation and Material Moving	105
Protective Service	83
Construction and Extraction	49
Production	34
Installation, Maintenance, and Repair	30
Food Preparation and Serving Related	27
Office and Administrative Support	15
Farming, Fishing, and Forestry	15
Management	13
Building and Grounds Cleaning and Maintenance	13
All other occupational groups	38
Unknown or Non-classifiable	85
Total	507

Table 3. Carbon Monoxide Case Counts by Source

Source of Carbon Monoxide Exposure	# Cases
Vehicle (car and truck)	218
Heater or furnace	52
Fire or smoke	38
Forklift, gas-powered	31
Saw, gas-powered	24
Pressure washer	18
Airplane engine	16
Fryer, grill, or oven	15
Generator	12
Carbon monoxide stored in holding tanks or cylinders	11
Welding gases	5
Air compressor	4
Sandbag filling machine	2
All other sources	19
Unknown source	42
Total	507

Table 4. Carbon Monoxide Cases from Vehicles by SOC Occupation Group

SOC Occupation Group	# Cases Exposed by Vehicles
Transportation and Material Moving	84
Protective Service	71
Installation, Maintenance, and Repair	15
Construction and Extraction	13
Office and Administrative Support	7
All other occupations	28
Total	190

Figure 2. Carbon Monoxide Cases among Protective Service Occupations by Injury Year

