National Collaborating Centre for Environmental Health

Centre de collaboration nationale en santé environnementale

Managing carbon monoxide in long-term care facilities and hospitals:

Meeting Report

Saskatoon, Saskatchewan
October 21, 2013

Introduction

As part of a three-year project funded by Health Canada's Indoor Air Contaminants Assessment Section, the National Collaborating Centre for Environmental Health (NCCEH), hosted by the BC Centre for Disease Control, held a carbon monoxide (CO) expert meeting in Saskatoon, SK on October 21, 2013. The meeting fulfilled the project's year three deliverable of bringing together experts to promote the development of a CO monitoring framework for long-term care (LTC) facilities and hospitals. The specific goals of the meeting were to: (1) develop a health-protective CO monitoring framework for LTC facilities and hospitals which includes establishing specific values that trigger a) maintenance, b) increased ventilation, and c) facility evacuation; and (2) suggest practical means to support the implementation of the framework. Participants were invited by the NCCEH based on their expertise in and experience with carbon monoxide, monitoring technologies, and facilities management. In total, 16 experts participated in the meeting (see Appendix A for a list of participants).

The meeting began with an overview of the project and meeting objectives (Prabjit Barn and Tom Kosatsky, BCCDC/NCCEH) followed by presentations on the health impacts of carbon monoxide (Renaud Vincent, Health Canada), toxicokinetic modeling of COHb levels based on CO concentrations in air and physiological vulnerabilities (Nathalie Gosselin, Pharsight Consulting Services), CO monitoring technologies (Hans Schleibinger, National Research Council) and the Saint Mary's Villa CO incident in Saskatoon including a summary of the incident, the immediate response, and Saskatoon Health Region's draft procedures for CO monitoring and reporting (Lori Frank, Al Krieger, and Lisa Williams, Saskatoon Health Region).

Most of the afternoon was dedicated to the discussion of four questions, along with others posed by the group throughout the day:

1. Are properly functioning, commercially available CO detectors protective of short- and medium-term exposures in persons with physiological vulnerabilities (cardiovascular disease, respiratory disease, anaemia, elderliness)?

    - Are current triggers sufficiently protective of all populations?
    - Are current logging capabilities of detectors sufficient for monitoring purposes?
2. What is the margin of safety for CO exposures in the short- and medium-term that would compensate for various conditions related to the monitoring framework, including sub-optimal monitor placement, moderate under-responsiveness, location of CO source, multiple sources, etc.
3. What alternate ambient concentration/duration algorithm would optimally protect vulnerable groups, including those with chronic obstructive pulmonary disease (COPD), cardiovascular disease, anaemia, and the elderly?
4. How could these health-protective measures be implemented in practice?

A summary of ideas and discussions generated throughout the meeting is presented in this report. The content does not necessarily reflect the views of individual participants.

Meeting Discussion

The presentations and four questions posed to participants served as a starting point for discussion in the afternoon portion of the meeting. During the discussion, the group brought forward two main points:

1. Focus should be expanded from monitoring to management of carbon monoxide in long-term care facilities and hospitals;
2. Short-term and long-term goals and recommendations should be developed in order to move the issue forward.

Management of carbon monoxide
A carbon monoxide management program should encompass prevention, education, and monitoring.

a. Prevention of carbon monoxide exposures:
    - Identification of all potential sources;
    - Hazard ranking of sources with considerations of situation and temporal nature of sources (e.g., which sources are prevalent in winter versus summer?);
    - Maintenance of sources (i.e., CO producing appliances)
        - Implement performance requirements to ensure emissions are kept low;
        - Distance sources from air intakes.

b. Education and awareness initiatives:
    - Develop tools to increase awareness of CO sources and ways to eliminate and reduce CO emissions and exposures;

- Ensure that building management staff understand how building design and heating, air conditioning and ventilation (HVAC) systems contribute to indoor carbon monoxide concentrations;
- Gear education to staff's roles and functions.

c. Monitoring of carbon monoxide to prevent acute and sub-acute exposures
    - The purpose of monitoring would be to: a) detect/identify malfunctioning appliances and the existence of intermittent sources (e.g., vehicles idling near air intakes) and b) allow for intervention/action when exposures are elevated;
    - The specific monitoring program implemented in a building should be tailored to the building design, complexity of the HVAC system, and the potential sources present;
    - A monitoring program should consider exposures at both the locations of sources (e.g., boiler room) and receptors (i.e., occupants);
    - For some sources, a "buffer" or "margin of safety" could be introduced by taking action when CO concentrations are detected at the source location (e.g., boiler room) before CO reaches occupied areas;
    - Decisions on detector technology and placement in the building should consider the following:
        - Monitoring needs within the facility, with respect to potential sources and exposures;
        - Possible interferences (e.g., relative humidity, temperature, other pollutants, etc.);
        - Logging capabilities needed for a monitoring program;
        - Management of monitoring data, including time and resource requirements;
        - Accuracy of detectors at low concentration ranges (i.e., those associated with health effects in vulnerable groups residing in LTC facilities).
    - Current trigger values at which CO detectors' alarm may not adequately protect vulnerable groups housed in LTC facilities, including those with cardiovascular or respiratory disease, anemia, and the elderly. Decisions on appropriate trigger values should consider the following:
        - No CO detectors were in place in Saint Mary's Villa at the time of the CO incident. The highest CO reading collected by the fire department and the energy company (the following morning, when the source was still emitting) was 63 ppm. This level may be an underestimation of the exposures that occurred throughout the night at the facility, but had this been the true exposure, CO detectors would not have been triggered. Such an occurrence suggests that current trigger values may be too

high to adequately protect vulnerable groups from experiencing adverse health effects;

- A large discrepancy exists between the indoor air guidelines (Health Canada, World Health Organization) and the standards used by the Canadian Standards Association (CSA) to approve CO detectors (see table below). While guidelines are based on CO exposures in air that would not result in internal blood COHb levels exceeding 2% in non-smokers, trigger values for CO detectors are based on a 10% COHb level target. This value was chosen by CSA in an effort to reduce the number of false alarms that were triggered at lower algorithms;

Table 1. Summary of indoor air guidelines for CO (Health Canada and World Health Organization) and standards (Canadian Standards Association) used to approve CO detectors

Organization	Averaging period	Value (ppm)	Target COHb (%)	Comments
Indoor air guidelines				
Health Canada[1]	1 hr	25	2	Target COHb value was derived from studies of individuals with coronary disease; therefore, considered protective of non-smoking populations and the entire population (for both short- and long-term exposures)
	24 hr	10		
World Health Organization[2]	15 min	87		Assuming light exercise and that exposure to these levels occurs only once per day
	1 hr	31		
	8 hr	9		Assuming light to moderate exercise
	24 hr	6		Assuming exposures occur when people are awake and alert but not exercising
Standards used to approve CO detectors				
Canadian Standards Association[3]	4-15 min	400 ppm	10	Target COHb chosen in an effort to reduce the number of false positive emergency calls made to first responders
	15-50 min	150 ppm		
	1-4 hr	70 ppm		

[1] Health Canada. Residential indoor air quality guide: Carbon monoxide. Ottawa, ON: Health Canada; 2010. http://www.hc-sc.gc.ca/ewh-semt/pubs/air/carbon_mono/index-eng.php

[2] World Health Organization. WHO guidelines for indoor air quality: selected pollutants. Geneva, Switzerland: WHO; 2010. http://www.euro.who.int/en/what-we-publish/abstracts/who-guidelines-for-indoor-air-quality-selected-pollutants.

[3] Canadian Standards Association. CSA 6.19-01. Residential Carbon Monoxide Alarming Devices. 2001.

- CO concentration/duration algorithms used to initiate action in response to indoor CO levels should not or cannot be lower than outdoor air quality objectives;
- There is a lack of experimental data investigating CO-related health effects in vulnerable groups. Toxicokinetic modelling that takes into account how physiological differences contribute to CO uptake and COHb formation can allow for a better understanding of health effects in vulnerable groups. As presented in the meeting, physiological differences can result in various COHb levels in persons at equivalent exposure levels. For example, CO exposures at 10 ppm over 24 hours (Health Canada guideline) results in average COHb levels between 4–5% for anaemic persons compared to levels < 2% in healthy individuals;
- The 2010 Health Canada Residential Indoor Air Quality Guideline is not currently scheduled for reassessment. Although no new experimental evidence exits, the guideline can be updated with modelling on estimated COHb levels corresponding to various CO exposures (concentrations and durations) in vulnerable groups.

Short-term and long-term goals and recommendations

Short-term goals and recommendations:

- Install CO detectors at all LTC facilities and hospitals;
- Monitor CO according to the draft monitoring and reporting system developed by Saskatoon Health Region, and evaluate the system to ensure that it is effective;
- Place detectors near the source to identify elevated levels and to introduce a "margin of safety" that would ensure high levels are immediately identified;
- Develop educational tools for staff on CO sources, emissions, and exposure reduction measures.

Long-term goals and recommendations:

- Improve infrastructure to eliminate potential sources of CO (e.g., CO-emitting appliances, air intakes in parking lots, poor HVAC systems, etc.);
- Ensure consistency through regional standardization of CO management in long-term care facilities and hospitals;
- Adapt existing CO detectors for monitoring in LTC facilities and hospitals. Ensure reliability of readings at low concentration ranges and consider developing data logging capabilities;
- Work with CSA to look at feasibility of lowering CO detectors' trigger values for the general public and for settings occupied by vulnerable groups;

- Conduct research, including modelling, to better understand CO-related health effects in vulnerable populations at acute, sub-acute, and chronic low-level exposures.

Moving forward

The objective of this meeting was to bring together experts to discuss the monitoring of carbon monoxide in LTC facilities and hospitals. Over the course of the day, the group heard from experts on the health impacts of CO, toxicokinetic modelling, and detector technologies. A presentation from Saskatoon Health Region discussed the 2010 CO incident in a LTC facility, as well as the draft monitoring and reporting program developed. This presentation offered lessons learned and identified challenges in moving forward to monitor CO. Overall, the group identified the need to manage CO in these settings, including prevention, education, and monitoring. Additionally, short-term and long-term goals and recommendations to best protect vulnerable populations in LTC facilities and hospitals were put forward. The participants emphasized the need for a clear mandate and funding from provincial governments to allow for the maintenance of infrastructure as well as to build capacity to deal with CO incidents in LTC facilities and hospitals. The need for consistency across jurisdictions, which would come from collaboration and dialogue between relevant jurisdictions, agencies, and organizations including the National Research Council, Health Canada, and NCCEH, was also highlighted.

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Appendix A

List of meeting participants

1. Tom Kosatsky, MD
   Environmental Health Services
   BC Centre for Disease Control
   Vancouver, BC
   Ph: 604-707-2447
   Email: tom.kosatsky@bccdc.ca

2. Prabjit Barn, MSc
   Environmental Health Scientist
   BC Centre for Disease Control and
   National Collaborating Centre for Environmental Health
   Vancouver, BC
   Ph: 604-707-2463
   Email: prabjit.barn@bccdc.ca

3. Renaud Vincent, PhD
   Head, Inhalation Toxicology Laboratory
   Environmental Health Sciences and Research Bureau
   Healthy Environments and Consumer Safety Branch
   Health Canada
   Ph: 613-941-3981
   Email: Renaud.Vincent@hc-sc.gc.ca

4. Rita Coshan, MSc
   Government of Saskatchewan
   Director Health Services
   Occupational Health and Safety Division, Ministry of Labour Relations and Workplace Safety
   6th Floor, 1870 Albert Street
   Regina, Canada S4P 4W1
   Ph: 306-787-4539
   Email: Rita.Coshan@gov.sk.ca

5. Nathalie H. Gosselin, PhD
   Senior Scientist, *Pharmacometrics*
   Pharsight Consulting Services™
   A division of Certara™
   Ph: 514-789-2174; Cell: 438-885-5149
   Email: Nathalie.Gosselin@certara.com

6. Michèle Bouchard, PhD
   Associate Professor, Head of the Chair in Toxicological Risk Assessment and Management
   University of Montreal
   Ph: 514-343-6111 ext 1640
   Email: michele.bouchard@umontreal.ca

7. Hans Schleibinger, PhD
   Group Leader
   National Research Council Canada
   Ventilation & Indoor Air Quality
   1200 Montreal Road
   Ottawa, Ontario K1A 0R6
   Ph: 613-993-9702
   Email: Hans.Schleibinger@nrc-cnrc.gc.ca

8. Tim Macaulay
   Director, Environmental Health Unit
   Population Health Branch
   Saskatchewan Ministry of Health
   Regina, Saskatchewan
   Ph: 306-787-7128
   Email: Tim.Macaulay@health.gov.sk.ca

9. Alan F. Krieger, A.Sc.T., BAC, PMP
   Regional Manager - Infrastructure Planning
   Facilities Management
   Saskatoon Health Region
   Ph: 306-227-7668
   Email: Al.Krieger@saskatoonhealthregion.ca

10. Dr. Michael Schwandt, MD
    Deputy Medical Health Officer
    Saskatoon Health Region
    Email: michael.schwandt@saskatoonhealthregion.ca

11. Don Figley, PhD, PEng
    Figley Consulting Associates Ltd.
    350 Crean Crescent
    Saskatoon, SK S7J 3X2
    Ph: 306-374-8141; Cell: 306-221-8964
    Email: figley.consulting@sasktel.net

12. Jenna Mouck, MCIP
    Director, Capital Asset Planning
    Strategy and Innovation Branch, Ministry of Health
    Email: Jenna.Mouck@health.gov.sk.ca

13. Margaret A. Ball, PEng, BEd, FEC
    Director of Construction Codes / Building Standards Engineer
    Building Standards and Licensing Branch
    Ministry of Government Relations
    100-1855 Victoria Avenue
    Regina, SK S4P 3T2
    Ph: 306-787-4520
    Email: margaret.ball@gov.sk.ca

14. Lisa Williams, RN
    Interim Enterprise Risk Management Consultant
    C/o Saskatoon City Hospital
    Ph: 306-655-7714
    Email: Lisa.Williams@saskatoonhealthregion.ca

15. Lori Frank
    Interprise Risk Management
    Ph: 306-655-7715
    Email: Lori.Frank@saskatoonhealthregion.ca

16. Paula Wright
    Coordinator
    Saskatoon Health Region
    Legal Counsel & Risk Management
    Saskatoon City Hospital – Level 1
    701 Queen Street
    Saskatoon, SK S7K 0M7
    Ph: 306-655-7795
    Email: Paula.Wright@saskatoonhealthregion.ca

17. Dale Gagnon
    Manager, Facilities Services
    Saskatoon Health Region
    Ph: 306-655-0684
    Email: dale.gagnon@saskatoonhealthregion.ca

18. Joan Wong, MSc
    Senior Evaluator
    Indoor Air Contaminants Assessment
    Water and Air Quality Bureau
    Health Canada
    Ph: 613-946-3542
    Email: joan.wong@hc-sc.gc.ca