Health Canada's Indoor Air Program: Risk Assessment and Research to Support Standards Development

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ABSTRACT

Health Canada, a science-based organization, is the Government of Canada's federal department responsible for maintaining and improving the health of Canadians. As Canadians spend on average 90% of their time indoors, indoor air quality is an important environmental determinant of health. Health Canada's Indoor Air program develops and promotes best practices to improve indoor air quality by conducting human health risk assessments of indoor air contaminants, research into indoor air quality and strategies to reduce exposure, and outreach and engagement initiatives to communicate risk to various audiences. The main output of risk assessment activities by the Indoor Air program are the Residential Indoor Air Quality Guidelines (RIAQGs), which consist of short-term and long-term health-based exposure limits. The RIAQGs provide the scientific basis for actions to reduce exposure and/or protect health, guide research to address data gaps, and inform the development of communication and outreach products and activities. These actions have included support for regulation and standard development, such as the CSA-0160-16 Formaldehyde emissions standard for composite wood products and the CSA 6.19-01 standard Residential carbon monoxide alarming devices with positive results. The future direction of Health Canada's Indoor Air program includes seeking more opportunities to engage in and provide evidence-based support for the development and/or update of standards and certifications that have the potential to directly impact indoor air quality in Canada.

INTRODUCTION

Air quality is an important environmental determinant of health. As Canadians spend on average 90% of their time indoors [1], indoor air quality is expected to have a significant impact on occupants' health and well-being. Health Canada is the Canadian federal department responsible to help maintain and improve health of Canadians [2] through the generation of knowledge through research, analysis, and evaluation. The Indoor Air Contaminants Assessment Section (IACAS) is part of the Air Health Program at Health Canada. IACAS develops and promotes best practices to improve indoor air quality by assessing, researching, and communicating the health impact of indoor air pollutants and strategies to reduce exposure. Indoor air quality (IAQ) is a complicated health issue that involves a variety of biological and chemical pollutants, with many sources. IAQ is heavily dependent on physical factors, such as ventilation, occupants' behaviour, housing characteristics and maintenance, as well as inherent individual susceptibility and vulnerability, that impact both exposure and health risk. Accordingly, the range of IACAS activities, outputs and target audience reaches beyond those of a traditional health risk assessment.

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ACTIVITIES OF THE INDOOR AIR CONTAMINANTS ASSESSMENT SECTION

IACAS employs an issue-based process with three main interconnected activities: risk assessment, research, and outreach as described in Figure 1.



Figure 1. Health Canada's IACAS undertakes three key interconnected activitied to improve and promote indoor air quality.

Risk Assessment

Risk assessments conducted by IACAS summarize the health risks of inhalation exposure to specific indoor air pollutants, provide information on exposure and sources in Canadian homes, and recommend ways to reduce exposure. We conduct risk assessment using a 4-step risk assessment method, similar to methods used by other internationally recognized health and environmental organizations: 1) an exposure assessment specific to Canadians, 2) a hazard identification based on a review of toxicology, epidemiology, or clinical trial sources, 3) an assessment of the dose-response relationship, and 4) a risk characterization.

The primary outputs of risk assessments are the Residential Indoor Air Quality Guidelines (RIAQGs), which include recommended health-based short-term (e.g. 1-hour) and long-term (e.g., 8-hour) exposure limits for indoor air contaminants in residential and other indoor settings. RIAQGs are are issued as voluntary objectives under the *Canadian Environmental Protection Act*, 1999 [3]. RIAQGs are published in two formats: a long-format Scientific Assessment Document, intended for a scientific audience, and a brief guideline document, intended for the public health community and the general public.

In some cases, a quantitative exposure limit cannot be derived from the available scientific evidence. When a quantitative limit is not derived, Residential Indoor Air Quality Guidance (to be referred to as Guidance document) is developed that describes actions to reduce exposure. Guidance documents are also published in long and short format, for scientific and general audiences, respectivley. To date, IACAS has published RIAQGs and Guidance documents for 10 key indoor air contaminants: acetaldehyde, benzene, carbon monoxide (CO), formaldehyde, fine particulate matter, mould, naphthalene, nitrogen dioxide, ozone, and toluene [4].

IACAS also publishes Indoor Air Reference Levels (IARLs), which are screening values selected from published assessments by internationally recognized health and environmental organizations, and represent exposure concentrations that are associated with acceptable levels of risk after long-term (lifetime) exposure. To date, IARLs have been published for 25 different volatile organic compounds commonly found in indoor air [5].



Figure 2. An example of a short-format RIAQG document intended for the public [4].

RIAQGs, Guidelines, and IARLs provide the scientific basis for actions to reduce exposure and/or protect health, guide research to address identified data gaps, and inform the development of communication and outreach products and activities.

Research

IACAS collabortates with Health Canada researchers, governmental, academic, and non-governmental partners, to plan, initiate, and engage in research related to IAQ. Our research program addresses three main goals with respect to indoor air contaminants: 1) to measure exposure levels, 2) to identify sources, and 3) to develop and test strategies to mitigate exposure. The results of this research support IACAS risk assessment activities, provide the scientific basis for the development of communication products and outreach activities, and support activities of other Health Canada programs (such as the Chemicals Management Plan). IACAS has initiated and supported indoor air monitoring studies in cities across Canada [6-12], researched indoor air quality in Canadian Indigenous and First Nations communities, evaluated effectiveness of ventilation strategies in schools [13], and conducted an intevention study testing IAQ mitigation strategies in attached garages [14]. These studies are published in peer-reviewed journals.

Risk Communication

Outreach and engagement, the third key activity of IACAS, is interconnected with the risk assessment and research activities. The findings of risk assessments and indoor air studies, particularly intervention studies, inform the content and strategy of Health Canada's outreach and engagement regarding indoor air quality. IACAS develops communications products and outreach initiatives to build awareness of the health risks of indoor air contaminants and promote strategies to reduce those risks. IACAS provides content and messaging for existing Health Canada, provincial, municipal, and non-governmental organizations' outreach activities, such as social media messaging, and visual factsheets for mould, CO and other IAQ issues. We also conduct our own direct outreach, including retail awareness campaings, such as CO awareness *Detect to Protect* campaign (detecttoprotect.ca).

IACAS publishes knowledge translation material for distribution, intended primarily for homeowners, as well as for public health and medical professionals and non-governmental organizations. For each RIAQG or Guidance document, a factsheet is developed, summarizing the evidence, providing the recommended health-based exposure limits, and risk mitigation recommendations in plain language. In addition, IACAS generates detailed factsheets and documents on various indoor air quality topics, such as moisture and mould [15], ventilation [16], cooking and indoor air quality [17], and flood cleanup [18], to inform Canadians on measures which can be taken to improve indoor air quality. Finally, IACAS has infographic series of visual factsheets [19], with infographics on ventilation, fine particulate matter (PM_{2.5}), CO, and mould, currently available [20-23].



Figure 3. A visual factsheet for CO, produced by IACAS [20].

With the objective of informing Canadians of the health effects of indoor air pollution, sources of indoor air contaminants, and ways to reduce their exposure to indoor air pollutants, Health Canada has engaged in a number of outreach initiatives. This includes ongoing activities, such as hosting information booths and presenting at various events, conferences, and trade shows, and contributing to initiatives led by provincial, municipal, and non-governmental partners.

Through a partnership with the City of Ottawa, IACAS developed a virtual reality house tool providing users with information about indoor air pollutants, the source of those pollutants, and ways to reduce exposure. The virtual reality tool allows the user to 'move' around an indoor residential environment (i.e., a model view of a typical Canadian home) and view information about common sources of indoor contaminants, in situ. This virtual house is presented at outreach events, and has proven to be an effective tool to engage the public and raise awareness of the health risks of indoor contaminants and strategies to reduce those risks.

IACAS funded and developed the *Detect to Protect* campaign, a collaboration between a large Canadian retailer and a manufacturer of CO alarms in Canada, to launch a public awareness initiative [24]. The goal of this campaign, conducted in November 2018, was to educate Canadians about the risks of CO and the importance of taking action, such as installing CO alarms in the home and maintaining combustion appliances. The retail campaign was launched in two Canadian provinces (Ontario and British Columbia) in order to compare the public awareness and knowledge of the health risks of CO in two regions of Canada with different legal requirements for the residential use of CO alarms. Local media were engaged and a social media campaign was conducted to promote the in-store events. Preliminary results of the campaign indicate it was successful, with an increase in the number of alarms purchased of 11.34 % and 13.6% in Ontario and British Columbia, respectively compared to the same month the year before the campaign and a significant number of visits to the campaign website and completed questionnaires.

Standards Development

With the goal of reducing Canadian's exposure to indoor air pollutants, IACAS supports the development of product/building standards and regulations that impact indoor air quality in Canada. IACAS played a direct role in the development and update of two National Standards of Canada dispersed by the Canadian Standards Association (CSA): *CSA-O160-16 Formaldehyde emissions standard for composite wood products* [25] and *CSA 6.19-17 Residential carbon monoxide alarming devices* [26], respectively. IACAS also contributed scientific expertise, particularly related to the health effects of ozone, in the development of *CSA 22.2 No. 187-15 Electrostatic air cleaners* [27]. In all three of these cases, our RIAQGs were used as the scientific basis for recommendations to reduce exposure [28-30].

Health Canada's Indoor Air program continues to seek additional opportunities to engage in and provide evidence-based support for the development and/or update of standards and certifications that have the potential to directly impact indoor air quality in Canada.

DISCUSSION

Indoor air quality is a complicated health issue, involving a variety of pollutants and dependent on a number of factors, which impact both exposure and health risk. As such, the Health Canada IACAS identifies and prioritizes specific indoor air quality issues according to the urgency, interest, and resources required, employing three main interconnected activities (i.e. risk assessment, research, and outreach) to address these issues. In the area of risk assessment, Health Canada publishes RIAQGs and Guidance documents, as well as IARLs, on key indoor air contaminants, providing health-based exposure limits and the scientific basis for further risk management activities. Health Canada-led exposure research provides information on levels of specific indoor air pollutants, characterizes sources of these pollutants, and evaluates interventions to reduce exposure. Results from risk assessment and research activities provide evidence-based information for communication and outreach activities, IACAS provides evidence-based support for the development and update of standards, based on the outcomes of our risk assessment and research activities. These interconnected activities provide the basis for the interconnections between risk assessment, research, and communication/ outreach activities is essential to the success of IACAS' ability to effectively address indoor air quality issues.

CONCLUSION

The mandate of the Health Canada IACAS is "to promote and protect the health of Canadians by evaluating, researching, and communicating the health effects of indoor air contaminants, and to contribute to developing solutions for improving indoor air quality." [29]. The interconnection between the research, risk assessment, and communication and outreach activities is essential to the success of IACAS' ability to meet this mandate to effectively address indoor air relation to health. In future, IACAS would like to further our mandate by supporting the development and updating of standards and regulations.

ABBREVIATIONS

IACAS - Indoor Air Contaminants Assessment Section

RIAQG - Residential Indoor Air Quality Guideline

IAQ - Indoor Air Quality

CO - Carbon monoxide

IARL – Indoor Air Reference Level

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