CSC smudging toxicity: literature review

Ko, Yoon

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/40002815
Client Report (National Research Council of Canada. Construction); no. A1-017894.1, 2022-07-26

NRC·CNRC CONSTRUCTION

CSC Smudging Toxicity: Literature Review

Author(s): Yoon J. Ko, Ph.D
Report No.: A1-017894.1
Report Date: March. 31st, 2021
Revision #1 Jul 26th, 2022
Contract No.: A1-017894
Agreement Date: Jun. 4th, 2020

National Research Council Canada | Conseil national de recherches Canada

Canada

PDF: Cat. No. NR24-91/2021E-PDF
ISBN 978-0-660-38295-1

CSC Smudging Toxicity: Literature Review

Author Ko, Yoon Digitally signed by Ko, Yoon Date: 2022.07.26 17:15:30 -04'00'

Yoon J. Ko, Ph.D,

Approved Singed as an acting program lead

Ahmed Kashef, Ph.D, P.Eng.
Program Leader
Research & Development, Fire Safety
NRC Construction

Report No: A1-017894.1
Report Date: 31, March, 2021,
Revision #1 Jul 26th, 2022
Contract No: A1-017894
Agreement date: 04, June, 2020
Program: Research & Development, Fire Safety

19 pages

Copy no. 1 of 1

Table of Contents

1 Introduction

Smudging activities are conducted in correctional facilities by inmates as part of a cultural ritual. *Correctional Service Canada (CSC) Commissioner's Directive (CD) 702: Aboriginal Offenders*[1] defines smudging as the act of burning traditional medicines (e.g. sweet grass, sage, cedar or tobacco) to pray and purify oneself or physical space. *CSC Standing Order (SO) 259: Millhaven Institution- Accommodation of Spiritual Practices*[2] further indicates that various types of tobacco including commercial tobacco may be used in circumstance.

A smudge is smoke producing/smouldering of a smudge material. In the previous study conducted for the CSC in 2018[3], the NRC (National Research Council Canada) tested three selected smudging materials to investigate how much smoke is generated from the smudging materials and how smoke detectors respond to the smudging. The previous study reported that the smudging sources produced large amounts of smoke although a limited amount of the smudging sources was burned using a small heat source (hot plate) in a test room. The level of smoke obscuration measured from the smudging sources was significantly higher than that resulted from the same amount of other smouldering sources (e.g. pieces of blanket, bed sheet and mattresses) tested in the room.

The CSC has requested a study to assess the effects of exposure to smudging smoke/effluents on human health. As an initial step, NRC conducted a literature review in collaboration with FireTox, LLC. to understand the types of effluents produced from smudging and their health hazards to inmates and correctional facility staff. A full report on the literature review is attached in Appendix A. The following sections provide a summary of the literature review report.

1.1 Objectives and scope

The purpose of the literature review study was to evaluate the types of combustion effluents produced from smudging activities and to assess the potential health effects of exposure to these smudging effluents to inmates and correctional facility staff.

2 Types of combustion effluents produced from smudging

Smudging, as smoldering combustion, produces higher yields of smoke when compared to flaming combustion. The range of combustion effluents depends on the chemical compositions of smudging materials.

Smudging uses sweet grass, sage, cedar, and tobacco or a combination thereof. Either pure form or commercially-processed tobacco may be used in CSC correctional facilities. An amount no more than two teaspoons of smudge is expected to be used in an individual ceremony, which can last a couple minutes, up to

[1] Correctional Service Canada (CSC). Commissioner's Direction 702: Aboriginal Offenders. November 11, 2013 (In Effect)

[2] Correctional Service Canada (CSC). Standing Order 259: Millhaven Institution- Accommodation of Spiritual Practices. April 2, 2012.

[3] Ko, Y., Weinfurter, M . 2018. Smoke detector response to smouldering fires and nuisance sources, NRC Report A1-012108-1, National Research Council Canada.

about 15 minutes. However, the types of smudging materials, their quantities and smudging durations vary as there are currently no specific restriction.

- Natural organic materials such as sage could emit common combustion by-products including the followings;
  - asphyxiant gases of carbon monoxide, carbon dioxide, nitric oxide
  - organic irritants (e.g. formaldehyde and acrolein),
  - polycyclic aromatic hydrocarbons (PAHs) and dioxins, and
  - Particulate matter (soot).

- Combustion of tobacco produces (potentially) harmful effluents as below;
  - Combustion effluents from pure form tobacco could include hydrogen cyanide (i.e. highly effective asphyxiant gas), and also due to soil contamination heavy metals and nitrites.
  - Commercially-processed tobacco produces a wide range of combustion effluents (over 93 harmful or potentially harmful substances) including, but not limited to, carbon monoxide, cadmium, lead, acrolein, acetaldehyde, benzene, ammonia, tobacco-specific nitrosamines, and 1-3-butadiene.

Very few studies attempted to quantify smudging toxicants. Cacique[4] smoldered sage and measured concentrations of particulates, nitrogen dioxide, carbon dioxide, total oxidants, sulfur dioxide, lead, and selenium. CSC conducted on-site measurement tests in Dorchester- New Brunswick and Saskatoon. The study from New Brunswick measured gaseous emissions (Nicotine, aldehydes, VOC's)[5], and the study from Saskatoon measured gaseous emissions and PM[6].

3 Health hazards of smudging effluents

Smoke is released from smudging as from most types of burning (e.g. flaming or smouldering), and smoke is a mixture of chemical effluents and smoke particles (soot). Both the chemical effluents and smoke particles pose health hazards, the extent of which depends on the concentration of each toxicant/smoke effluent and smoke particles present in the environment.

To estimate the health risk of exposure to smudging, it is necessary to know concentration data of each smoke effluent and smoke particle. There are not many data published on concentrations/yields of combustion by-products from smudging sweet grass, sage, and cedar, except one study which attempted to quantify smudging toxicants and their impact on indoor air quality.

- Chemical effluents from smudging

  From smudging sage, the study reported no measurable quantities of lead, nitrogen dioxide, or total oxidants, little to no sulfur dioxide or selenium, and carbon dioxide concentration within normal ranges.

---

[4] Cacique, A. (2015). The Effects of Ceremonial Smudging on Indoor Air Quality, Nawayee (Center) School.
[5] R. Mazerolle, "Indoor air quality survey (smudging ceremony)." "Indoor air quality survey (smudging ceremony)," Workplace Health and Public Safety Programme (WHPSP) -Health Canada, Westmorland institution, Dorchester, New Brunswick, 2008.
[6] L. Maheaux, "WHPSP Saskatoon office for testing in June, 2008 SMUDGING REPORT," Occupational Hygiene Field Support Unit of the Workplace Health & Public Safety Programme of Health Canada, Jun. 2008.

No data is available for toxicant yield and mass loss rates of smudging sweet grass, cedar and other materials. Given that sage, sweet grass, and cedar are natural organic matter composed of hydrogen, carbon, and oxygen, the effluents produced from combustion of such organic matters in general include asphyxiant gases (e.g. carbon monoxide, carbon dioxide, nitric oxide), organic irritant gases e.g. formaldehyde and acrolein) and carcinogens (polycyclic aromatic hydrocarbons (PAHs) and dioxins).

- Smoke Particles

  During the combustion of organic materials, such as smudging materials, smoke particles/ particulate matters are released, and the particulate matters are composed of complex organic and inorganic compounds of varying sizes. Inhalation of particulate matters can cause major health effects, in particular for very fine particles since particulate matters with a diameter of 2.5 µm or less ($PM_{2.5}$) can travel into the respiratory tract and deposit within the alveoli.

  A reported data of particulate matter measured from a sage smudging was 76 µg/m^3 in one-hour which is slightly less than the *Alberta one-hour $PM_{2.5}$ guideline*[7] of 80 µg/m^3. It should be noted that *the Canada-Wide Standard outdoor air quality guideline*[8] for $PM_{2.5}$ is 28 µg/m^3 averaged over a 24-hour period. For indoor air quality, *Health Canada*[9] has rescinded a previously prescribed indoor $PM_{2.5}$ concentration, because "PM_{10} and $PM_{2.5}$ are considered to be non-threshold substances, meaning that health effects may occur at any level of exposure."

4 Mitigation Strategies

To find mitigation strategies for smudging, a review was conducted on current policies and guidelines currently employed by other Canadian organizations. Four existing smudging policies were reviewed, and common strategies implemented are a requirement for advanced notification and room signage prior to smudging.

Thus, to reduce the risk of adverse health effects from exposure to smudging by-products, the following mitigation strategies are recommended;

- Require advanced notification of staff and other occupants as to the day, time and place of the smudging activity (i.e. notifications in advance will accommodate needs for ventilation and fire safety/alarm systems)
- Post signage and notify staff/occupants to ensure that smudging does not pose a health risk to attendees, particularly individuals with severe asthma and respiratory issues.
- Limit smudging to designated indoor and outdoor locations which have been verified to have adequate ventilation, compatible fire protection systems, and appropriate fire safety equipment (e.g. fire extinguishers, fire exit and fire alarm pull station);

---

[7] CAREX Canada (2020). Outdoor Air Pollution Profile. Retrieved from ttps://www.carexcanada.ca/profile/outdoor_air_pollution/

[8] Canadian Council of Ministers of the Environment (CCME) (2012). Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone, Winnipeg, Manitoba.

[9] Health Canada (2020). Residential indoor air quality guidelines. Retrieved from https://www.canada.ca/en/health-canada/services/air-quality/residential-indoor-air-quality-guidelines.html#a1

- When locations cannot be designated, ensure adequate ventilation and/or limit the quantity of material and duration of the activity; and
- Limit or ban the use of commercially-processed tobacco.

5 Next step

This literature review was conducted to establish the typical composition of smudging materials, probable combustion effluents, and yields of combustion effluents. However, it is found that an insufficient amount of information exists particularly on yields of effluents produced during smudging. Therefore, it is recommended to conduct physical testing/modeling and carry out exposure assessment.

Appendix A

FireTox

168 West Main Street # 422, New Market, MD 21774 Tel: (301) 580-1181 *www.firetox.com*

ASSESSMENT OF SMUDGING ACTIVITIES CONDUCTED BY INMATES IN CANADIAN CORRECTIONAL FACILTIES

by

Jamie L. McAllister, Ph.D., P.E., C.S.P.
Fire Protection Engineer and Toxicologist

FireTox, LLC.
168 West Main Street, #422 New Market, MD 21774

Submitted to:
National Research Council of Canada Construction Fire Safety
Attn: Dr. Yoon Ko 1200 Montreal Road, M-59 Ottawa, Ontario, K1A 0R6

January 13, 2021

BACKGROUND

The purpose of this study was to evaluate the types of combustion effluents produced from smudging activities conducted by Aboriginal correctional facility inmates. Additionally, this study assessed the effects of exposure to these smudging effluents to determine whether smudging activities present a health hazard to inmates and correctional facility staff. The scope of work included two tasks: 1) a literature review to establish the typical composition of smudging materials, probable combustion effluents, and yields of combustion effluents, and 2) the potential impacts from exposure to these effluents and recommendations for mitigation or minimization of exposure.

In Task 1, the literature review specifically addressed the following:

- General background information on smudging as well as specific information related to its occurrence in correctional facilities.
- Type of material(s) burned during smudging.
- Quantity of material(s) burned during smudging.
- Typical durations of material burning, as well as, characteristics of burning, e.g. flaming, smoldering, etc.
- Typical combustion effluents and their yields.

In Task 2, the exposure assessment specifically addressed the following:

- Exposure doses likely to be present during smudging.
- Routes of exposure to smudging effluents.
- Hazards associated with smudging effluents as well as the specific hazard of the anticipated dose of smudging effluents.
- Mitigation strategies to reduce or prevent exposure.

This report presents Task 1 and Task 2 findings as well as recommendations for future work needed to more precisely evaluate the risks associated with smudging activities inside Correctional Service Canada (CSC) facilities.

ANALYSIS

Task 1: Literature Review

Smudging is generally defined as “a ceremony for purifying or cleansing the soul of negative thoughts of a person or place.” [1]. CSC Commissioner’s Directive (CD) 702: *Aboriginal Offenders* further defines “smudging” as “the act of burning traditional medicines to pray and purify oneself or physical space. It is also an act of unity, used to open ceremonies to prepare participants for healing or sharing. The burning of tobacco in the context of smudging is not the same as smoking cigarettes.” [2]. Smudging is not specific to Aboriginal correctional facility inmates, but rather is a spiritual and cultural ritual performed by many individuals both inside and outside of

correctional facilities.

Type of Materials

CSC CD 702 defines "traditional medicines" as "sacred, natural medicines used during ceremonies which may include sweet grass, sage, cedar or tobacco." [2]. According to CSC, "Typically smudging uses sweet grass, sage and tobacco or a combination thereof." [3]. Specifically, regarding tobacco, CSC Standing Order (SO) 259: *Millhaven Institution- Accommodation of Spiritual Practices* indicates that "Elders may bring in various types of tobacco in their bundles. Ceremonial or traditional tobacco in its pure form, and has no added chemicals. Commercial tobacco may be used in exceptional circumstances, such as when traditional is run out, or when external people bringing offerings to the Elder." [4]. CSC CD 259: *Exposure to Second Hand Smoke* prohibits the smoking of tobacco inside correctional facilities and within the outdoor perimeter of correctional facilities except when tobacco is "used for the purpose of Aboriginal, and other religious and spiritual practices…" [5]

Quantity of Materials

According to CSC, the quantity of material used during smudging is "approximately a teaspoon (at most)" [3]. Correspondence from CSC indicated that Aboriginal Initiatives representatives take measures to limit the smudging material used for individual ceremonies to "two teaspoons." [6]. It is understood, based upon additional correspondence from CSC, that when smudging is performed using a bowl, 1-2 teaspoons of material is utilized; however, CSC CD 702 does not limit smudging activities to bowls. Additionally, CSC SO 259 states "As part of tradition an inmate may present a tobacco tie to the Elder. It is given directly to the Elder, or put in the sacred fire, as per traditional protocols." [4]. In these instances where tobacco ties are used or where the smudging material may be in a bundle or ball, the quantity of material burned could exceed 1-2 teaspoons.

Type and Duration of Burning

Smudging is a smoldering combustion process. The plant leaves and/or stems are ignited and then flames are blow out "and the smoke…is wafter over the person." [1]. The duration of burning of the smudging material is specific to the smudging activity. According to CSC, individual smudging ceremonies "should not take more than a couple of minutes" whereas group smudging ceremonies occurring in the Cultural Center could "last up to 15 minutes." [7]. However, CSC CD 259 and CD 702 do not limit the duration of smudging activities [2, 5].

Combustion Effluents and Yields

Sage, sweet grass, and cedar are natural organic matter composed of hydrogen, carbon, and oxygen [8]. As such, the effluents produced from combustion of these materials are also composed of hydrogen, carbon, and oxygen, and compounds formed from nitrogen found in the combustion air.

Common combustion by-products are carbon monoxide, carbon dioxide, nitric oxide, organic irritants (e.g. formaldehyde and acrolein), polycyclic aromatic hydrocarbons (PAHs), dioxins, and particulate matter [9, 10].

Pure form tobacco contains nicotine which is composed of nitrogen in addition to carbon and hydrogen. As such, hydrogen cyanide is produced during combustion of pure form tobacco, in addition to those combustion products already mentioned above. Due to contamination of soil, it is also possible for pure form tobacco to contain heavy metals and nitrites [11]. The burning of commercially-processed tobacco is estimated to produce over 93 harmful or potentially harmful effluents including, but not limited to, carbon monoxide, cadmium, lead, acrolein, acetaldehyde, benzene, ammonia, tobacco-specific nitrosamines, and 1-3-butadiene [11]. CSC CD 259 prohibits the smoking of tobacco inside correctional facilities and within the outdoor perimeter of correctional facilities to protect correctional staff members, inmates, and visitors from exposure to second hand smoke. However, CD 259 does allow smoking of tobacco as part of approved Aboriginal and religious practices [5]. It is important to note, however, that the hazards associated with second hand smoke produced from habitual tobacco smoking/burning is no different than the hazards associated with second hand smoke produced from spiritual or cultural tobacco smoking/burning; smoke produced from burning tobacco is carcinogenic in both instances.

The yield of combustion products is dependent upon two factors: a) the mass fraction of carbon, hydrogen, oxygen, nitrogen, and other elements in the fuel, and b) the efficiency of the combustion process. In general, smoldering combustion (as occurs with smudging) produces higher yields of asphyxiant gases and irritant gases when compared to flaming combustion [12, 13]. The yield of combustion products (Y_p) can be represented as

$$YY_{pp} = \frac{mm_{pp}}{mm_{ff}}$$

where m_p is the mass release rate of toxic product and m_f is the mass loss rate of the fuel. While the yield of toxicants is higher in smoldering fires when compared to flaming fires, the production rate of toxicants is lower due to slower burning rates [13]. In evaluating the health hazards associated with exposure to combustion products, it is necessary to know the concentrations of the toxicants present in the environment. The concentrations are derived from the burning material's mass loss rate and toxicant yields under the specific combustion condition (i.e. smoldering, flaming). Numerous studies have investigated mass loss rates and yields from wood and tobacco, but little is known about the mass loss rate and toxicant yields for sweet grass, sage, and cedar. Moreover, the studies on tobacco have focused on cigarettes as opposed to the smoldering of loose tobacco, as is used in smudging.

A review of the literature produced only one study which attempted to quantify smudging toxicants and their impact on indoor air quality [14]. In the study, Cacique [14] smoldered 5 grams of sage in a small box (2 ft x 2 ft x 2 ft) for one hour and measured concentrations of particulates, nitrogen dioxide, carbon dioxide, total oxidants, sulfur dioxide, lead, and selenium. Five different sources of sage were tested. The focus of the study was on concentrations of pollutants likely to be present inside a classroom so the measured concentrations inside the small box were reduced to account for the volume differences between the test box (2 ft x 2 ft x 2 ft) and a standard classroom (10 ft x 20 ft x 20 ft). Cacique [14] found no measurable quantities of lead, nitrogen dioxide, or total oxidants and little to no sulfur dioxide or selenium. An average carbon dioxide concentration of 560 ppm was reported which is within normal limits. Normal carbon dioxide concentrations in occupied spaces with adequate ventilation range from 350-1000 ppm [15]. Particulate matter with a diameter of 2.5 μm or less ($PM_{2.5}$) were found in concentrations above ambient air quality limits. The average $PM_{2.5}$ for the five sages tested was 62.3 $\mu g/m^3$, 66.5 $\mu g/m^3$, 40.8 $\mu g/m^3$, 50.8 $\mu g/m^3$, and 72.3 $\mu g/m^3$, respectively (minimum = 35 $\mu g/m^3$, maximum = 76 $\mu g/m^3$).

An absence of lead, sulfur dioxide, and selenium in the combustion effluent of the sage is not surprising, as neither lead, sulfur, nor selenium are present in sage or in normal combustion air. The Cacique study was focused on air pollutants and toxicants commonly measured to assess indoor air quality. As such, the study did not evaluate other toxicants of interest in this study, such as organic irritant gases and carcinogens. None the less, the Cacique study provides a starting point for the Task 2 exposure assessment.

Task 2: Exposure Assessment

Exposure Dose

The Cacique study found that burning 5 grams of sage for one hour would produce a maximum $PM_{2.5}$ of 76 $\mu g/m^3$ in a 4000 ft^3 room [14]. Based upon information provided by CSC, smudging ceremonies are expected to last approximately 15 minutes, however, there is no policy which limits the duration of a ceremony. To perform the exposure assessment, the $PM_{2.5}$ value found in the Cacique study was utilized as a conservative, worse-case scenario.

Routes of Exposure

When assessing the health risk associated with a toxicant, it is important to understand the primary route of exposure. The route of exposure relates to the amount of chemical effectively absorbed and distributed into the body. The four main routes of exposure that are considered when evaluating a toxicant are inhalation, dermal, ingestion, and injection. The route of exposure to $PM_{2.5}$ is through inhalation.

The dermis can also be a route of exposure to some smudging effluents. Carbon monoxide, carbon

dioxide, hydrogen cyanide, and nitrogen oxides do not effectively penetrate through the skin; however, organic irritants and carcinogens, such as PAHs and dioxins can penetrate through the skin at sufficient concentrations. Because little is known about the concentrations of organic irritants and carcinogens produced during smudging, this analysis will only focus on the inhalation of $PM_{2.5}$.

Smudging Effluent Hazards

The particulate matter released during the combustion of organic materials is composed of a complex mixture of organic and inorganic compounds of varying sizes. The ability of the particulate matter to enter the respiratory system, and the depth of its travel into the respiratory system, is controlled by the particle's diameter. Particulate matter with a diameter of 10 μm or less (PM_{10}) is capable of penetrating and depositing within the upper respiratory tract [10]. $PM_{2.5}$ can travel even further into the respiratory tract and deposit within the alveoli [10]. Ultrafine particles ($PM_{0.1}$) are smaller than 0.1 μm and can migrate from the respiratory system into the systemic circulation [10].

Epidemiological studies evaluating the impact of air pollution have shown a relationship between increased concentrations of $PM_{0.1}$, $PM_{2.5}$ and PM_{10} and daily deaths, hospital admissions, and cardiac and respiratory illnesses [10]. Some particles, particularly $PM_{0.1}$ can produce free radicals in the lung tissue which results in oxidative stress and inflammation leading to respiratory distress and illness [10]. The particulate matter also carries with its various chemical contaminated; carcinogenic PAHs are commonly present in particulate matter [10].

The Canada-Wide Standard outdoor air quality guideline for $PM_{2.5}$ is 28 $\mu g/m^3$ averaged over a 24-hour period [16, 17]. There is no Canada Wide Standard outdoor air quality guideline for a 1- hour period, however, the province of Alberta does have a 1-hour average of 80 $\mu g/m^3$ [16]. The 24-hour and 1-hour guidelines only apply to outdoor air quality. Currently, there are no specific guidelines on indoor air quality in Canada; the guidelines simply state to "keep indoor levels of $PM_{2.5}$ as low as possible." [18]. Previous Canadian limits on residential indoor air quality (set in 1987) were rescinded based upon newer research which suggests that there is no lower threshold below which $PM_{2.5}$ has no adverse effect [19]. As stated by Health Canada, "PM_{10} and $PM_{2.5}$ are considered to be non-threshold substances, meaning that health effects may occur at any level of exposure." [19].

At minimum, it is prudent to ensure that $PM_{2.5}$ indoor air concentrations do not exceed the guidelines for outdoor air quality. Given that the Cacique data was derived from a 1-hour test, the Alberta guidelines will be utilized for this analysis. In the Cacique study, one test reached a $PM_{2.5}$ concentration of 76 $\mu g/m^3$ in one-hour which is slightly less than the Alberta one-hour $PM_{2.5}$ guideline of 80 $\mu g/m^3$ [14, 16]. Although limited in scope, the Cacique study suggests that smudging activities can produce $PM_{2.5}$ concentrations approaching the maximum outdoor air quality guidelines based upon the Alberta criteria. Moreover, Health Canada advises to "keep indoor levels of $PM_{2.5}$ as low as possible" and further that "health effects may occur at any level of exposure."

[18, 19]. Based upon these findings, individuals within the room in which the smudging activity is occurring would be at risk to adverse health effects. To the extent that air is recirculated within a CSC facility, it is possible for smudging effluents to be carried into locations outside of the area where the activity is occurring. As such, those remote from the activity could also be at risk to adverse health effects. Furthermore, if smudging is occurring in spaces with no containment, e.g. no doors or open cells, smudging effluent could adversely impact the health of those surrounding the area.

Mitigation Strategies

An obvious mitigation strategy to eliminate indoor air quality concerns would be to require all smudging activities to be performed outdoors, however, this strategy may be considered overly restrictive. A literature review was conducted to benchmark the current CSC policies against existing smudging policies and guidelines implemented by other Canadian organizations. Reasonable administrative controls and risk mitigation strategies were identified as part of this review. A total of four policies were found and are summarized below. Common language found throughout all the policies is marked in bold.

The Manitoba Education and Training, *Smudging Protocol and Guidelines for School Divisions* indicates that smudging may occur in a classroom, a gym, or outdoors [20]. Signage is recommended to **notify** individuals that smudging occurs within the facility, within a specific room, or as part of a specific activity. The policy encourages consideration for those that are participating in smudging as well as those who do not participate in the practice. To protect those with severe asthma or respiratory illnesses, the policy includes the following steps:

- "Smudging in **well-ventilated** areas."
- "Using **small amounts** of sage in each smudge."
- "Making **fans** available for teachers' use as needed."
- "Making **air purifiers** available for teachers' use as needed."

The policy also requires advance **notification** of parents, staff, and students as to the day, time, and place of the smudging activity. In addition, the policy references a study that was undertaken to evaluate the impact of smudging on indoor air quality. The policy indicated "smudging particulate dissipates relatively quickly. Moreover, air quality in areas adjacent to a smudging was minimally changed and easily returned to its pre smudge state within recommended air quality guidelines." Specific parameters, such as ventilation conditions, room volume, smudging duration, and material, were not disclosed; therefore, it is not reasonable to assume the same findings would be true in CSC correctional facilities.

The McMaster University, *Smudging Protocol for Burning of Traditional and Sacred Medicines* indicates that smudging may occur anywhere on the campus [21]. Additionally, three permanent smudging locations are identified: Ceremonial Space, Indigenous Studies Courtyard, and Indigenous Circle/Gathering Place. When an individual wishes to smudge, they are required to do the following:

- "Post an 'Intent to Smudge' **Notice** on their office or residence door, whenever possible."
- "Keep their door closed during the Smudging Ceremony."
- "Post 'Intent to Smudge' **Notices** within the vicinity of the Smudging Ceremony, whenever possible."
- "Arrange with Environmental and Occupational Health Support Services to have Facility Services perform an initial **ventilation** and/or **fire system assessment** of their office or residence room."
- "Be aware of the nearest **fire extinguisher**, fire exit and fire alarm pull station."
- "Ensure that all remnants of the Smudging ceremony are properly taken care of once the Smudge is complete."
- "Direct all requests at off-site campus locations to the appropriate building management and/or security group(s)."

When smudging occurs as part of a communal ceremony, the Instructors or Smudging Facilitators is required to do the following:

- "**Notify** Environmental and Occupational Health Support Services at least five (5) business days before the scheduled event in order to assess the need for action with respect to **ventilation**, **fire safety and alarm systems**. Notification should be provided to McMaster Security Services on evenings or weekends. If five (5) business days is not possible, Instructors/Facilitators are asked to attempt to perform Smudging Ceremonies at one of the three (3) Permanent Smudging Sites."
- "Inform all participants that participation in the Smudging Ceremony is completely voluntary."
- "Post "Intent to Smudge" **Notices** within the vicinity of the Smudging Ceremony."
- "Be aware of the nearest **fire extinguisher**, fire exit and fire alarm pull station."
- "Ensure that all remnants of the Smudging ceremony are properly taken care of once the Smudge is complete."

The Ontario Federation of Labour, *Guidelines for Indigenous Smudge Ceremony* [22] indicates the following requirements applicable to health and safety:

- "A staff/committee member should provide at least 48 hours advanced **notice**, internally and externally to participants, that a smudge will be lit on a specific day, time and place."

- "With guidance from the person who is leading the smudge, a staff/committee member will identify where and when smudging will be allowed at an event/gathering place. The staff member will also ensure the necessary materials for the smudge ceremony is acquired."
- "A staff/committee member should **notify** the venue at least 24 hours prior to a labour event that a smudging ceremony is planned."
- "On the event/meeting day, **signs** should be posted at the venue to indicate that a smudge ceremony is scheduled or in progress. Signs can include the following: Today, an Indigenous Smudging Ceremony will occur in this gathering space. Smudging is often part of a labour function. All are welcome to participate as a matter of choice."
- "Prior to the start of a ceremony, a staff/committee member should ensure that smudging does not pose a **health risk to attendees**, particularly individuals with severe asthma and respiratory issues."
- "If the ceremony does pose a health risk to attendees, particularly individuals with **severe asthma and respiratory issues**, the staff/committee member should work with the Elder or person leading the smudge to identify a different space/location outside the meeting space to hold the ceremony."
- "During the ceremony, a staff/committee member must ensure that **no burning materials** are **left unattended** and that all burning material are doused immediately after the conclusion of the smudging ceremony."

The Northwest Catholic District School Board, *Smudging Protocol and Guidelines* indicates that designated spaces, both indoors and outdoors, will be made available for smudging [23]. According to the policy, the ventilation and fire alarm systems within these designated spaces have been assessed to ensure "issues will not disrupt the building occupants." The following procedures are required when conducting "occasional smudging indoors":

- "Prior to any smudging, ensure that the head caretaker is advised of the date, time and exact location. Giving **notice** recognizes the importance of smudging as a cultural practice and recognizes that some members of the community may sensitive and/or allergic. Individuals are encouraged to alert their supervisors so alternate arrangements can be made for **vulnerable persons** in the vicinity of the smudging. Responsibility for the safe and appropriate use of the sacred medicines rests with the lead participant(s) of the event."
- "**Signage** will be posted on the door of the room where the smudge is being held and the main office. Once the aroma of the smudge has dissipated the sign will be removed."
- "The person responsible for the smudge must know the location of the nearest fire extinguisher, be aware of nearby combustible materials."
- "The smudge bowl must rest in an area with **non-combustible** materials. The smudge bowl used must be capable of withstanding the heat of the smudge bundles. Embers must be kept in a heat proof container until cold to the touch before discarding."

- "The area must be **supervised** by program staff during the smudging ceremony."
- "When smudging outside, smudging must occur at least **40 feet from any structure**. The Principal will ensure that the ground conditions are suitable to performing the smudging ceremony; e.g. in extremely dry conditions."

The following procedures are required for “permanent indoor smudging locations”:

- "The principal will consult with the Head Caretaker regarding smudging activities taking place on site."
- "Installation of an **exhaust fan** (where required) will be as per specifications established within the Ontario Building Code (Part 6 and the TNCDSB Standard)."
- "The person responsible for the smudge must know the location of the nearest **fire extinguisher**, be aware of nearby combustible materials, and keep embers in a heat proof container until cold to the touch before discarding. A fire extinguisher must be permanently mounted in the room."
- "There can be **no flammable materials** or **large quantities of combustible** materials located in the designated room during the smudging ceremony."
- "The Principal shall communicate the specific smudging room number to all staff. A **sign** must be posted on the designated room door. Once the aroma of the smudge has dissipated the sign will be removed."
- "The room MUST be **supervised** by program staff during the smudging ceremony."

A common theme throughout the four policies is a requirement for advanced notification and room signage prior to smudging. In most cases, the purpose of notification and signage is a) to ensure that the space has adequate ventilation and the necessary safety equipment, and b) to ensure that notice has been given to everyone, particularly those with respiratory illnesses, of the potential to be exposed to smudging effluents.

Based upon a review of the above referenced documents, it is recommended that CSC implement the following controls to mitigate risks associated with smudging activities in their correctional facilities:

- Require advanced notification to designated CSC staff of the day, time, and place that smudging will occur.
- Post signage on the outside of rooms where the smudging activity will take place to ensure that susceptible individuals, such as those with asthma or respiratory illnesses, are aware of the planned smudging activity.
- Consider limiting smudging activities to only designated indoor and outdoor locations which have already been verified to have adequate ventilation, compatible fire protection systems, and appropriate fire safety devices.

- Where smudging activities cannot be limited to a designated area, ensure that there is adequate ventilation within the space where smudging will occur and/or limit the quantity of material and duration of the activity.
- Limit or ban the use of commerically-process tobacco to reduce the number of hazard effluents present during the smudging activity.

RECOMMENDATIONS FOR FUTURE WORK

Based upon the findings in this report, it is recommended that a third task be completed to include physical testing and modeling. More specifically, Task 3 should include the following:

- Perform small-scale testing to establish yields of combustion effluents for three (3) most common material compositions as determined in Task 1.
- Perform full-scale testing in the laboratory or at a CSC correctional facility, or perform computerized modeling, to determine concentrations likely to be present in designated smudging locations with consideration for the specific ventilation conditions present in those locations.
- Analyze toxicant data and apply findings to exposure assessment and recommendations from Task 2.

Limited research is available which suggests that $PM_{2.5}$ concentrations approach air quality limits during smudging, however, this research did not evaluate the mass loss rate or yields of carbon monoxide, organic irritants, and carcinogens also produced during smudging. To comprehensively evaluate the hazards associated with smudging, the concentrations of the numerous toxicants within the combustion effluent should be evaluated to establish the impact on indoor air quality and to establish potential adverse health effects. Furthermore, to refine the CSC protocol and define adequate ventilation, limited quantities, and acceptable durations of activity, it is necessary to determine the burning rate and yields of combustion products from the smudging activity.

CONCLUSIONS

The following conclusions can be made based upon the above analyses:

- Smudging uses sweet grass, sage, cedar, and tobacco or a combination thereof. Either pure form or commercially-processed tobacco may be used in CSC correctional facilities.
- Individual ceremonies generally involve no more than two teaspoons of smudge; however, in instances where tobacco ties are used or where the smudging material may be in a bundle or ball, the quantity of material burned could exceed 1-2 teaspoons.
- The duration of burning is specific to the smudging activity. Individual smudging ceremonies may last a couple of minutes with group smudging ceremonies lasting up to 15 minutes.

- Common by-products from combustion of natural, organic materials such as sage are carbon monoxide, carbon dioxide, nitric oxide, organic irritants (e.g. formaldehyde and acrolein), polycyclic aromatic hydrocarbons (PAHs), dioxins, and particulate matter.
- Hydrogen cyanide is produced during combustion of pure form tobacco. Heavy metals and nitrites may also be present due to soil contamination.
- Commercially-processed tobacco produces over 93 harmful or potentially harmful combustion effluents including, but not limited to, carbon monoxide, cadmium, lead, acrolein, acetaldehyde, benzene, ammonia, tobacco-specific nitrosamines, and 1-3- butadiene.
- It is necessary to know the concentration of a toxicant present in the environment in order to evaluate exposure risk.
- The concentration of a combustion by-product can be determined by knowing the mass loss rate and toxicant yields of the burning material.
- Numerous studies have investigated mass loss rates and yields from wood and tobacco, but little is known about the mass loss rate and toxicant yields for sweet grass, sage, and cedar.
- A review of the literature produced only one study which attempted to quantify smudging toxicants and their impact on indoor air quality.
- Smudging sage, Cacique found no measurable quantities of lead, nitrogen dioxide, or total oxidants, little to no sulfur dioxide or selenium, and carbon dioxide concentration within normal ranges. Cacique did find elevated concentrations $PM_{2.5}$.
- The Cacique data is a starting point to perform a worse-case scenario exposure assessment assuming a maximum $PM_{2.5}$ of 76 $\mu g/m^3$.
- The primary exposure route for $PM_{2.5}$ is inhalation, and $PM_{2.5}$ can travel into the respiratory tract and deposit within the alveoli causing respiratory illness.
- The Canada-Wide Standard outdoor air quality guideline for $PM_{2.5}$ is 28 $\mu g/m^3$ averaged over a 24-hour period.
- There is no Canada Wide Standard outdoor air quality guideline for a 1-hour period, however, the province of Alberta does have a 1-hour average of 80 $\mu g/m^3$.
- Currently, there are no specific guidelines or limits on indoor air quality in Canada; the guidelines simply state to "keep indoor levels of $PM_{2.5}$ as low as possible."
- Health Canada has rescinded a previously prescribed indoor $PM_{2.5}$ concentration, because "PM_{10} and $PM_{2.5}$ are considered to be non-threshold substances, meaning that health effects may occur at any level of exposure."
- Four existing smudging policies were reviewed for benchmarking. A common theme throughout the policies is a requirement for advanced notification and room signage prior to smudging.
- The following mitigation strategies are recommended to reduce the risk of adverse health effects from exposure to smudging byproducts : 1) Require advanced notification, 2) Post signage, 3) Limit smudging to designated indoor and outdoor locations which have been verified to have adequate ventilation, compatible fire protection systems, and appropriate fire safety equipment, 4) When locations cannot be designated, ensure adequate ventilation and/or

limit the quantity of material and duration of the activity, and 5) Limit or ban the use of commercially-processed tobacco.

- Based upon the findings in this report, it is recommended that a third task be completed to include physical testing/modeling and another exposure assessment.

REFERENCES

1. Indigenous Corporate Training, Inc. (2017). A Definition of Smudging, Retrieved from https://www.ictinc.ca/blog/a-definition-of-smudging

2. Correctional Service Canada (CSC). Commissioner's Direction 702: Aboriginal Offenders. November 11, 2013 (In Effect).

3. Email correspondence from Marty Maltby to Michael Kruszelnicki, December 7, 2016.

4. Correctional Service Canada (CSC). Standing Order 259: Millhaven Institution-Accommodation of Spiritual Practices. April 2, 2012.

5. Correctional Service Canada (CSC). Commissioner's Directive 259: Exposure to Second Hand Smoke. March 17, 2014.

6. Email correspondence from Michael Kruszelnicki to Yoon Ko, July 7, 2020.

7. Email correspondence from Michael Kruszelnicki to Yoon Ko, October 19, 2020.

8. Craft, J. D., Satyal, P., & Setzer, W. N. (2017). The Chemotaxonomy of Common Sage (Salvia officinalis) Based on the Volatile Constituents. Medicines (*Basel, Switzerland*), 4(3), 47. https://doi.org/10.3390/medicines4030047

9. Stec, A. A., & Hull, T. R. (2016). Fire Toxicity (1st ed.). Woodhead Publishing.

10. Purser, D.A., Maynard, R. L., & Wakefield, J. C. (2015). Toxicology, Survival and Health Hazards of Combustion Products (Issues in Toxicology, Volume 23) (1st ed.). Royal Society of Chemistry.

11. United States Food & Drug Administration (2020), Chemicals in Cigarettes: From Plant to Product to Puff, Retrieved from https://www.fda.gov/tobacco-products/products-ingredients-components/chemicals-cigarettes-plant-product-puff.

12. Purser, D.A. & McAllister, J.L. (2016). Assessment of Hazards to Occupants from Smoke, Toxic Gases, and Heat. In *SFPE Handbook of Fire Protection Engineering* (5th ed.). Quincy, Massachusetts: National Fire Protection Association.

13. Rein, G. (2016) Smoldering Combustion, In *SFPE Handbook of Fire Protection Engineering* (5th ed.), Quincy, Massachusetts: National Fire Protection Association.

14. Cacique, A. (2015). The Effects of Ceremonial Smudging on Indoor Air Quality, Nawayee (Center) School.

15. Bonino, S. (2015). Carbon Dioxide Detection and Indoor Air Quality Control, Occupational Health & Safety, Retrieved from https://ohsonline.com/Articles/2016/04/01/Carbon-Dioxide-Detection-and-Indoor-Air-Quality-Control.

16. CAREX Canada (2020). Outdoor Air Pollution Profile. Retrieved from https://www.carexcanada.ca/profile/outdoor_air_pollution/

17. Canadian Council of Ministers of the Environment (CCME) (2012). Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone, Winnipeg, Manitoba.

18. Health Canada (2020). Residential indoor air quality guidelines. Retrieved from https://www.canada.ca/en/health-canada/services/air-quality/residential-indoor-air-quality-guidelines.html#a1

19. Health Canada (2016). Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air Quality, https://www.acee.gc.ca/050/documents/p80054/119376E.pdf

20. Manitoba Education and Training (2019). Smudging Protocol and Guidelines for School Divisions, https://www.edu.gov.mb.ca/iid/publications/pdf/smudging_guidelines.pdf

21. McMaster University, Smudging Protocol for Burning of Traditional and Sacred Medicines, Retrieved from https://healthsci.mcmaster.ca/docs/librariesprovider59/mcmaster-university-smudging-protocol/mcmaster-university-smudging-protocol.pdf?sfvrsn=e3804f3c_2

22. Ontario Federation of Labour (2018). Guidelines for Indigenous Smudge Ceremony, https://ofl.ca/wp-content/uploads/OFL-Guidelines-for-Indigenous-Smudge-Ceremony.pdf

23. The Northwest Catholic District School Board, Smudging Protocol and Guidelines, https://www.tncdsb.on.ca/Board/Protocols/Documents/TNCDSB%20Smudging%20Protocol%20Dec%202018%20(2).pdf