Abstract
Inhalant abuse — also known as volatile substance abuse, solvent abuse, sniffing, huffing and bagging — is the deliberate inhalation of a volatile substance to achieve an altered mental state. Inhalant abuse is a worldwide problem that is especially common in individuals from minority and marginalized populations, and is strongly correlated with the social determinants of health. It often affects younger children, compared with other forms of substance abuse, and crosses social and ethnic boundaries. Inhalants are pharmacologically diverse products that are selected for their low price, legal and widespread availability, and ability to rapidly induce euphoria. Chronic abuse is associated with serious and often irreversible effects. Widespread screening and early referrals to treatment programs have resulted in significant improvements in the mental, physical and social conditions of those affected. The present statement reviews critical aspects of inhalant abuse, highlighting new information and data that pertain to Aboriginal children and youth, and provides recommendations for treatment and prevention.

Key Words: Abuse; Inhalant; Solvent; Volatile substance

Inhalant abuse, which is also known as volatile substance abuse, solvent abuse, sniffing, huffing and bagging, is the deliberate inhalation of a volatile substance to achieve an altered mental state. It often affects younger children, compared with other forms of substance abuse, and crosses social and ethnic boundaries. Inhalant abuse is a worldwide problem that is especially common in individuals from minority and marginalized populations, and is strongly correlated with the social determinants of health. The present statement reviews critical aspects of inhalant abuse, highlighting new information and data that pertain to Aboriginal children and youth, and provides recommendations for treatment and prevention. It replaces the previous Canadian Paediatric Society statement published in 1998 [2].

Epidemiology
Lack of recognition, social stigma, changing trends and apparent regional differences, along with differences in survey methods, make accurate reporting of inhalant abuse epidemiology difficult. The Canadian Addiction Survey [3] — a randomized telephone survey — noted that 1.3±0.3% of Canadians 15 years of age and older reported lifetime use of inhalants in 2004, compared with 0.8±0.2% in 1994. Inhalants are legal, inexpensive and easy to obtain, all of which may account for the higher abuse potential among young children. In a 2007 United States (US) face-to-face survey [4], 1.1% of youth aged 12 to 13 years had used inhalants in the past month, and 66.3% of respondents 12 years of age and older were children when they first abused inhalants. Notably, 10.7% of respondents reported inhalants as their first drug of abuse. Both the American and Canadian surveys excluded the homeless and incarcerated; thus, the prevalence of inhalant abuse may be even higher. Research also varies in the categorization of different substances and which ones qualify as ‘inhalants’.

In a self-administered survey of youth from the US, fewer students from the same class cohort claimed to have ever abused inhalants in later years [5]. These findings may have occurred because some students who were abusing inhalants may have left school or forgotten their inhalant experiences when questioned later. Or, perhaps older students considered inhalant abuse to be less socially acceptable and were, therefore, more reluctant to report its use. The perception of inhalants as ‘kid’s drugs’ (along with the use of the generic and innocuous-sounding term ‘glue sniffing’ for inhalant abuse) has been described. This perception may explain the epidemiological trends of inhalant use.
abuse and deserves consideration by health care professionals [4].

Inhalant abuse is more common in school dropouts, those who have been physically or sexually abused or neglected, the incarcerated and the homeless, as well as among Aboriginal communities [1][3][8]. Differences among other ethnic groups and between sexes are more ambiguous. Inhalant abuse is more prevalent among rural communities, as well as isolated communities with high rates of unemployment, poverty and violence [1]. It is also correlated with reduced family support or deviant family environments, poor school performance, poor self-esteem and suicidality, psychiatric conditions, other substance abuse, and substance-abusing family and peers [1][8]. Inhalant abuse is an international problem that is closely linked with the social determinants of health. Children and youth from different social backgrounds initiate inhalant use for different reasons; for example, in the developing world, inhalant abuse is often done to relieve symptoms of hunger [3].

### Abused chemicals and products

Inhalants are pharmacologically diverse volatile products that are frequently selected for their low price, legal and widespread availability, and ability to rapidly induce euphoria. A grouping by pharmacology and patterns of abuse has resulted in three categories: aliphatic, aromatic or halogenated hydrocarbons; nitrous oxide; and volatile alkyl nitriles [10][11] (Table 1). The most commonly abused substances reported to US poison centres from 1996 to 2001 were gasoline (41%), paint (13%), propane/butane (6%), air fresheners (6%) and formalin (5%). The majority of inhalant-related deaths were caused by gasoline (45%), air fresheners (26%) and propane/butane (11%) [12].

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tr>
<td>Categories, examples, and chemicals present in commonly abused inhalants</td>
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<tr>
<td><strong>Category</strong></td>
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<tr>
<td>Aliphatic, aromatic and halogenated hydrocarbons</td>
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<tr>
<td>Fuels including cigarette lighters</td>
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<tr>
<td>Paint/polish removers, paint thinners, felt-tip markers, correction fluids, glues and rubber cements</td>
</tr>
<tr>
<td>Varnishes, lacquers, resins, lacquer thinners</td>
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<tr>
<td>Dry cleaning fluids, spot removers, degreasers</td>
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<tr>
<td>Computer/electronics cleaning sprays</td>
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<tr>
<td>Vegetable oil cooking sprays</td>
</tr>
<tr>
<td>Medical anesthetics</td>
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<tr>
<td>Nitrous oxide</td>
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<td>Volatile alkyl nitrites</td>
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### Immediate effects

‘Sniffing’ or ‘snorting’ involves the direct inhalation of fumes, ‘bagging’ from a plastic or paper bag, ‘huffing’ from a rag or cloth soaked in the substance held over the mouth or nose, ‘glading’ from air freshener aerosols, and ‘dusting’ involves the direct spraying of
aerosol cleaners into the mouth or nose [10][11]. Often, several deep inhalations are needed to achieve full euphoric effects. Rapid pulmonary absorption and lipid solubility mean that the brain is rapidly affected [13]. The greatest concentration of inhalant can be obtained through ‘bagging’ and ‘huffing’; thus, these methods of abuse are preferred [14].

Initial effects are similar to those of anesthetics: stimulation, disinhibition and euphoria. These sensations may be followed by hallucinations and then a general depression including slurred speech and disturbed gait, dizziness, disorientation, and drowsiness or sleep within seconds to minutes [13]. Rebreathing when ‘bagging’ potentiates the intoxication by causing hypcapnia and hypoxia [15]. Further drowsiness and headache can persist for hours because of residual intoxication. Tiredness and sleep often limit the degree of intoxication [13]. Inhalants have a wide range of effects on neurotransmitter release and receptors, with a few similar cellular actions as those of other depressants such as benzodiazepines, alcohol and barbiturates [16].

Volatile alkyl nitrites, such as those indicated for angina, have vasodilatory effects, resulting in hypotension and syncope and sensations of warmth and flushing. ‘Poppers’ and their sensations have been associated with dance clubs and sexual activity; they have also been used for their sphincter relaxation effect and penile engorgement in young men for anal sex, with links to increased HIV transmission [17]. Inhalants of various types have been reported to cause freezing and burning of the face and upper aerodigestive tract [18].

Respiratory arrest due to central nervous system depression has been reported in at least one case, and sudden cooling of the larynx (by direct spraying of aerosols) has been suggested to cause fatal vagal depression [19]. Likely due primarily to cardiac arrhythmia, ‘sudden sniffing death syndrome’ is the leading cause of death among inhalant abusers. Inhalants disrupt myocardial electrical propagation – an effect heightened by hypoxia – increasing the risk of arrhythmia. Inhalants also sensitize the heart to adrenaline; sudden sniffing death can occur when a user is startled during inhalation (such as being caught inhaling) or in vivid hallucinations [19]. Deaths and injuries from acute abuse often result from dangerous behaviour (eg, drowning, falls or jumps, burns or hypothermia) due to disinhibition and feelings of invincibility, while aspiration and suffocation, especially when ‘bagging’, can also be fatal [10].

Long-term effects
Chronic abuse has been shown to have drastic and irreversible neurological and neuropsychological effects, likely due to damage of myelin and neuronal membranes by lipophilic chemicals [15]. More concentrated in neural tissue than in blood, these chemicals can cause cortical atrophy and lesions visible with neuroimaging. Inhalants have been known to result in brainstem dysfunction and a variety of motor, cognitive and sensory deficits [20]. Signs may include irritability, tremor, ataxia, nystagmus, slurred speech, decreased visual acuity and deafness [13].

Inhalant abuse can cause cardiomyopathy with distinct electrocardiographic changes [21]. Dyspnea, emphysema-like abnormalities and other pulmonary deprivations, distal renal tubular acidosis and hepatitis can be caused by inhalant abuse [22]. Hydrocarbons can result in bone marrow toxicity (causing aplastic anemia and leukemia) [23], while volatile nitrites have been implicated in immune impairment and the replication of HIV and Kaposi’s sarcoma, and the creation of carcinogenic nitrosamine and methemoglobin as metabolites [13].

Women who are occupationally exposed to solvents have more menstrual disorders, and preeclampsia and spontaneous abortions are more common in pregnant women who abuse inhalants [24]. Teratogenic effects secondary to maternal exposure to inhalants may lead to ‘fetal solvent syndrome’ with associated congenital neurological defects including microcephaly and cognitive impairments [25]. Signs of neonatal withdrawal include high-pitched cry, and disturbed sleep and feeding [26].

Inhalant abuse is associated with poor school performance, criminal behaviour, abuse of other substances, social maladjustment, low self-esteem and suicidalty [14]. Causality of these phenomena has not been established; they may be as much predecessors or a direct cause of inhalant abuse.

Detection
The signs of inhalant abuse are often more subtle than with other abused substances. Effects are experienced rapidly and disappear quickly [11], and only small amounts of a substance are required. Furthermore, abused products are typically legal, making their purchase and storage less conspicuous. Abusers may have unusually large caches of inhalants, perhaps stored in atypical places (such as under a child’s bed).
Chronic users may have clear physical signs: odour on the breath that can linger for hours, stains, paint, glitter and/or odour on skin or clothing. Presentation may also include perioral dryness or pyodermas, the ‘huffer’s rash’ (may be yellow in nitrite abusers) or even facial, oral/nasal or esophagopharyngeal freezing or burning, sometimes with secondary edema of lips, oropharynx and trachea. Other obvious signs may be manifestations of neuropsychological impairment (such as confusion, moodiness or irritability) and pulmonary toxicity (including wheezing, emphysema and dyspnea). Severe toxicity may be detected with more pronounced central nervous system depression such as ataxia, tremor and nystagmus. Friends and family may suspect heavy abuse by noticing poor hygiene, weight loss, fatigue, nosebleeds, conjunctivitis, muscle weakness, nausea, apathy, poor appetite and gastrointestinal complaints, changes in school attendance or psychological/psychiatric changes. High prevalence of mood, anxiety and personality disorders has been correlated with inhalant abuse, and should be considered in both detection and subsequent treatment.

Analysis for urinary metabolites of certain solvents (benzene, toluene, xylene and chlorinated solvents) may be conducted to ensure treatment compliance, but generally routine urine screening and other laboratory tests do not detect inhalant abuse. Although it may be the most valuable tool in inhalant abuse detection, screening is seldom performed by health care providers. Health professionals are advised to consider a screening tool such as the CRAFFT questionnaire (Table 2), and to be aware of appropriate techniques in its administration including private interviews as well as involving family members in assisting with collecting a more complete history. Additionally, family, peers, teachers, counsellors and others should be made aware of the signs of inhalant abuse and how to refer children and youth who may be at risk.

**TABLE 2**

<table>
<thead>
<tr>
<th>CRAFFT Screening Tool</th>
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<tr>
<td>C Have you ever ridden in a car driven by someone (including yourself) who was “high” or had been using alcohol or drugs?</td>
</tr>
<tr>
<td>R Do you ever use alcohol or drugs to relax, feel better about yourself, or fit in?</td>
</tr>
<tr>
<td>A Do you ever use alcohol or drugs while you are by yourself or, alone?</td>
</tr>
<tr>
<td>F Do you ever forget things you did while using alcohol or drugs?</td>
</tr>
<tr>
<td>D Do your family members or friends ever tell you that you should cut down on your drinking or drug use?</td>
</tr>
<tr>
<td>T Have you ever gotten into trouble while you were using alcohol or drugs?</td>
</tr>
</tbody>
</table>

Two or more “yes” answers indicate a potential substance abuse problem and the need for further assessment. Reproduced with permission from reference [51]. © Canadian Medical Association.

Widespread screening for youth and the incarcerated has resulted in successful referrals to treatment programs, while the Screening, Brief Intervention, and Referral to Treatment (SBIRT) pilot program in the United States resulted in 22.7% of 459,599 patients screening positive for some degree of involvement in, or risk of, substance abuse. Early referrals to treatment programs have resulted in significant improvements in the physical, mental and social conditions of those affected.

**Intervention and treatment**

Inhalant abusers may not seek medical attention, except in cases of related injury or serious illness. Effective treatment is not available for acute inhalant intoxication and withdrawal, apart from extra-vigilant and supportive care. Management may include the use of antiarrhythmics or beta-blockers to stabilize the myocardium and avoid over-stimulation by catecholamines; sympathomimetics should be avoided. Hypotension is common and cardiopulmonary status must be monitored, along with mental status. Skin and clothing may require decontamination. Patient history from peers and family must be taken, an assessment of the patient’s neurological status is critical, and laboratory investigations to screen for liver, kidney and heart damage are important. Withdrawal may influence treatment; varying manifestations have
been reported, such as nausea, anorexia, sweating, tics, sleep disturbance and significant changes to mood [13][28][36].

Inhalant abusers are younger and suffer greater social dysfunction than abusers of other substances. Therefore, inhalant-specific treatment programs are required, and should include time for detoxification, use of a peer-patient advocate system, development of strengths and skills, and appropriate transition back into the community [37]. Considerations for other substance dependencies, or the presence of psychiatric or physical disorders, must be made and co-current conditions should be treated. Early treatment – assisted by early detection by widespread screening – and extended treatment periods improve outcomes [38][39]. Families of inhalant abusers are often dysfunctional, and family therapy and social family contracting with parental reinforcement and enforcement of the youth’s appropriate behaviour may also be effective in treatment. Finally, referring health professionals should make themselves available during and following treatment to encourage and facilitate the uptake of parenting, parent support and youth social skills programs that may reduce the risk of relapse [39].

Prevention
Almost unequivocally, prevention is considered the most effective strategy in combating inhalant abuse. Prevention methods must aim to reduce the social acceptability of abuse and should be comprehensive and community based, involving not only abusers and family members, but also peers, schools and retailers [40].

Involving the producers of abused legal products in inhalant abuse prevention interventions has had mixed results. Legislation in three American states was abandoned after difficulty in finding suitable additives to make substances unpleasant to abusers, and compulsory labelling of constituent chemicals in inhalants has made products likely to be abused easier to identify [40]. Australia has had some success in replacing harmful components in products, mostly driven by environmental requirements [41]. Retailers and manufacturers can also partner in prevention education [40].

Preteens are at risk of inhalant abuse; therefore, evidence-based in-school primary prevention education must begin early to ensure that its messages have been delivered before – not in the midst of – youth inhalant abuse [42]. Office-based brief interventions including a 5 min to 10 min session outlining the risks associated with substance use have been found to be effective in reducing alcohol, marijuana and tobacco use [42]. However, similar strategies have not been shown to be effective for inhalant abuse, in which perceptions of harm are more strongly correlated with social networks than with future intent to use inhalants [43]. Availability and use of inhalants by peers correlate with inhalant abuse, with many youths reporting abuse at friends’ homes and on school property [44]. In addition, inhalant abuse is correlated with poverty, hunger, illness, low education levels, unemployment, boredom and feelings of hopelessness [45]. Thus, it is clear that prevention must also address the influence of social factors including the social determinants of health. Intersectoral action that includes partnerships among community agencies, the private sector and government is required to disseminate information and education on inhalant abuse, and develop policies that address inhalant abuse prevention [40][45].

Considerations for Aboriginal children and youth
Several studies [47] have found higher rates of inhalant abuse in some Aboriginal populations (in particular Inuit and First Nations communities, but with no studies specific to Métis). Importantly, however, as with the abuse of other substances, these higher rates are likely due to socioeconomic status and not inherent to the populations’ ethnicities [45][49]. In some communities, it has been reported that inhalant abuse is denied or normalized – although media reporting of abuse may have skewed views of its prevalence (49). Health disparities, reduced access to services and socioeconomic factors may contribute to these higher rates. The unique social and health contexts, as well as the widespread nature of inhalant abuse in some communities, has led to the development of culturally specific treatment programs.

The National Youth Solvent Abuse Program (NYSAP), was founded between Health Canada and First Nation communities to increase youths’ ability to deal with adversity and access to support through stronger cultural identity [50]. Treatment is long term and residential (creating a safe place that is separate from the home community), and aims to involve spiritual components in healing – a critical component of program success. Clients are encouraged to find and use supports in their communities and schools, and family participation is required. The success of the program continues to grow because it establishes proactive outreach services to prevent inhalant abuse, considers other abused substances in its treatment of inhalant abusers, and con-
continues to incorporate research on the outcomes of its treatment and prevention efforts.

### Conclusion and recommendations

The Canadian Paediatric Society is extremely concerned with the practice of inhalant abuse among children and adolescents, and believes that more needs to be done to understand and combat this dangerous practice. Health professionals must make themselves aware of key points regarding inhalant abuse, including the following:

- epidemiology and trends;
- its signs and symptoms, effects and dangers, and the treatment of acute cases;
- screening techniques; and
- the availability of local resources for prevention, intervention and treatment.

Health professionals must be ambassadors of education, working with children and youth, parents, schools, teachers, media and policy-makers, especially regarding the following:

- types and examples of abused chemicals;
- signs and dangers of inhalant abuse;
- intervention and treatment: what to do if someone suspects another is abusing; and
- combating misconception: advise that even casual substance abuse is dangerous.

Health professionals should use their knowledge, experience and community connections to achieve the following:

- play a guiding role in creating a network of health and community care for inhalant abusers;
- guide policy regarding inhalant abuse prevention education and treatment;
- ensure that the social determinants of health affecting inhalant abuse are understood and considered in policy;
- advocate for the replacement of dangerous and psychoactive substances in common products with less harmful alternatives; and
- advocate for and contribute to research that increases our understanding of inhalant abuse – including epidemiology, and effective prevention and treatment strategies that address the social determinants of health – particularly in Aboriginal peoples, with research that is specific to First Nations, Métis and Inuit populations.

Health services and authorities should ensure access to effective family-based treatment programs, including long-term residential treatment when required.

### Acknowledgements

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Principal Author: Lola Baydala MD